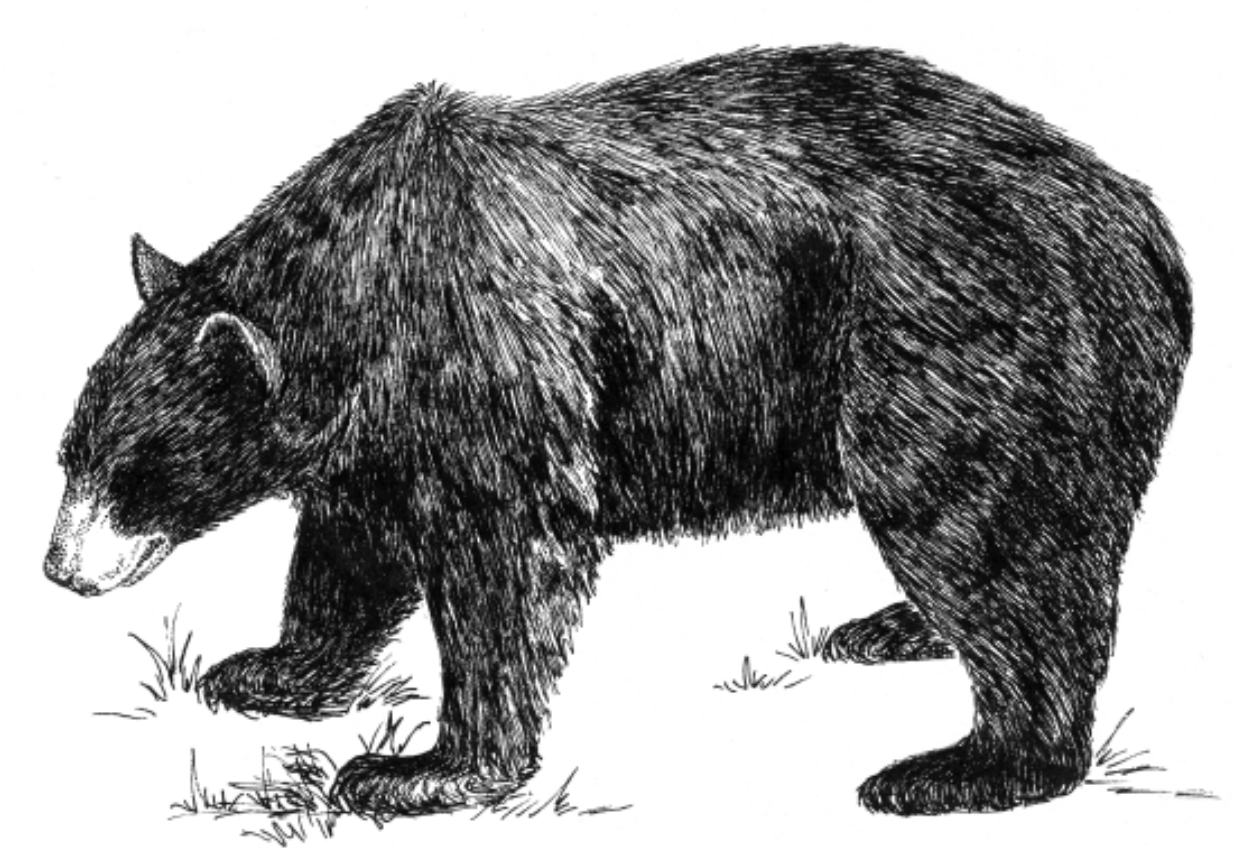
BLACK BEAR ASSESSMENT AND STRATEGIC PLAN 1999



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INTRODUCTION

Since 1968, the Maine Department of Inland Fisheries and Wildlife (MDIFW) has aggressively pursued development and refinement of wildlife species assessments and implementation of cost-effective comprehensive programs that support selected goals and objectives for the next 15 years. Assessments are based upon available information and the judgments of professional wildlife biologists responsible for individual species or groups of species. Precise data may not always be available or are too limited for meaningful statistical analysis; however, many trends and indications are sometimes clear and deserve management consideration.

The assessment has been organized to group information in a user-meaningful way. The Natural History section discusses biological characteristics of the species that are important to its management. The Management section contains history of regulations and regulatory authority, past management, past goals and objectives, and current management. The Habitat and Population sections address historic, current, and projected conditions for the species. The Use and Demand section addresses past, current, and projected use and demand of the species and its habitat. A Summary and Conclusions sections summarizes the major points of the assessment.

NATURAL HISTORY

Description

The American black bear (*Ursus americanus*) is the smallest of the three species of bears found in North America, and is the only bear inhabiting the Eastern United States (Pelton 1982). Black bears have compact bodies, stocky limbs, a massive skull, and short, round ears (Kolenosky and Strathearn 1987). Males grow 50% larger than females, reaching 6 ft from nose to tail, and stand 40 inches at the shoulder; females will reach 5 ft in length, and rarely stand more than 30 inches at the shoulder (Kolenosky and Strathearn 1987). Males normally weigh 250-350 pounds, with large specimens weighing over 500 pounds; adult females weigh 150-200 pounds but can exceed 300 pounds or more in unusual circumstances (Kolenosky and Strathearn 1987).

Maine black bears are nearly always black in color with a brown-blond muzzle; about one in four have a white chest patch, or “blaze” (MDIFW file data). However, elsewhere in North America, black bears exhibit a variety of color phases. In western States and Provinces, black bears are commonly some shade of brown, ranging from a deep chocolate through a reddish-brown “cinnamon” phase to blonde (Pelton 1982, Kolenosky and Strathearn 1987). A white color phase is found in coastal British Columbia, and coastal Alaska and British Columbia are home to a bluish-gray phase of the black bear (Kolenosky and Strathearn 1987).

Black bears have dense, coarse fur, with guard hairs that can grow up to four inches long during the late winter, and a woolly undercoat that insulates them from cold temperatures and wet weather. They are plantigrade (walk on the flat of their feet), and appear clumsy. However, bears are capable of short bursts of speed, and have been clocked at nearly 35 miles per hour (Kolenosky and Strathearn 1987). Black bears are strong swimmers, and have been observed swimming over 1.5 miles to reach offshore islands (Lindzey and Meslow 1977). They have short curved claws, useful for digging in soil, extracting insects from decaying wood, and climbing trees (Rogers 1987).

Bears have well developed senses of smell and hearing (Kolenosky and Strathearn 1987). They can distinguish color and have good near vision, but black bears do not distinguish objects at a distance as well as humans (Bacon and Burghardt 1976).

Bears pass the winter months of food shortage by entering a lethargic state (torpor), usually within an enclosed den. Across North America, their denning period may last from less than a month to over 7 months, depending upon latitude and seasonal abundance of food. In Maine, bears usually enter dens from mid October - late November, and emerge in late April. They usually do not eat, drink, urinate, or defecate for the entire period (Folk et al. 1972). Bears undergo several physiological changes during the denning period to minimize energetic demands. Their body temperature drops slightly, and their breathing and heart rate are dramatically depressed (Folk et al. 1972). Although denned bears are in a deep sleeping state, they are easily aroused and will sometimes leave their dens if disturbed.

Distribution and Status

Historically, black bears occurred throughout all forested regions of North America (Pelton 1982). Following European settlement, bear numbers and distribution were reduced by deforestation and excessive killing. By the late 1800’s, black bears were absent from much of their former range in the southeastern United States, and their populations were severely restricted in most of the remainder of the East. Early in the twentieth century, the Industrial Revolution and concurrent decline of agriculture allowed northeastern forests to reclaim abandoned farmland. Bears were given greater protection by the 1950s, and have repopulated much of their historic range in the North. Black bears are slowly recolonizing vacant habitat in Missouri, Kentucky, Ohio, New Jersey, and Maryland. Southeastern bear populations have expanded in the lower Appalachian Mountains, but many coastal plain populations remain isolated due to permanent loss of forested habitat and travel corridors. Habitat conversion has not been a significant factor for black bear conservation in the western

United States and throughout Canada and Alaska, where bears remain in good numbers. The current North American black bear population numbers about 750,000, and regional populations are secure in all but the extreme south and southeastern United States.

Food Habits

Black bears are omnivores. Vegetation makes up most of their diet, but they will eat a variety of animal matter obtained as carrion or prey (Pelton 1982). Insects and colonial beetles are a small but important part of their diet, and bears also consume a variety of mammals, birds, reptiles and amphibians (Pelton 1982). Although they have traditionally been considered inefficient predators of mammals (Pelton 1982), black bears are important predators of juvenile deer, moose, caribou, and elk (Ballard 1994).

In the Northeast, bears begin feeding in early spring on new herbaceous growth in moist forest openings and wetlands; on the buds and new leaves of aspen, birch and maples; and on nuts remaining on the forest floor from the previous fall's crop (Spencer 1955, Hugie 1982, Lamb 1983, Caron and McLaughlin 1985). As spring progresses to summer, bears take advantage of ripening berries and the abundance of insect life. They begin to eat hazelnuts and apples in early September, and start to climb for beechnuts, often breaking the tops of beech trees as they feed. Most berries dry up in mid-September, and nuts drop to the forest floor to become the dominant late fall food of bears.

Although acorns and apples are an additional fall food source in southern and western portions of the State, in northern Maine bears are restricted to one major food item: beechnuts. Beechnut crops fluctuate widely in abundance; in Maine, years of plentiful beechnut crops are often followed by years when beechnuts are scarce to nonexistent. When shortages of natural foods occur, bears often eat human-associated foods (e.g., garbage, bird food, bee hives, cultivated crops) that are high in protein, fat, and/or carbohydrates.

Habitat Requirements

The black bear is closely associated with forestland throughout North America. Forests supply black bears with food and escape cover, and provide shade that may help regulate their body temperature. Bears do not persist in open grasslands or open agricultural areas without tree cover. The species occurs throughout a range of forest types across the continent, from the cypress swamps of the Southeast to the temperate deciduous forests of the East and coniferous forests of the North and West.

In the Northeast, bears use forest stands of different ages, size classes and species composition, depending upon the season (Hugie 1982, Lamb 1983, Elowe 1984, Schooley 1990). Their movements and activities are largely determined by the distribution and developmental stages of vegetation that they use as food. In the spring, bears will visit the edges of wetlands, roadsides, recently clear-cut areas, and agricultural fields to feed on newly emerging grasses and herbaceous vegetation. They also frequent regenerating stands of aspen and mature hardwoods to eat buds and new leaves. If the previous fall's beechnut or acorn crops were abundant, bears will move to mature beech or oak stands to eat nuts that over wintered on the forest floor.

During the summer months, bears continue to use roadside openings and regenerating forests, including recently clearcut and partially cut stands of hardwood and softwood. These areas provide an abundance of berries and insects, and usually contain dense understories for escape cover. By fall, bears move to mature hardwood-dominated stands to take advantage of beechnut and acorn crops, and to a lesser extent, beaked hazelnuts and persistent berries of mountain ash and cherries. If nut crops are scarce, bears may forage on cranberries and winterberries along the fringes of wetlands. They will also visit the fringes of agricultural areas to feed on apples, corn and oat crops, but rarely venture far into open areas devoid of protective cover.

Throughout the year, bears are never far from dense cover; swamps, thickets and regenerating clearcuts are preferred resting sites. Mature softwood stands provide escape and resting cover, but little food regardless of the season of the year. Timber harvesting improves softwood stands as bear habitat by opening the canopy and stimulating growth of understory vegetation, providing spring and summer foods. Harvesting of hardwood stands can likewise be beneficial to bears provided enough mature trees remain following cutting to ensure nut production.

Black bears den in a variety of cover types, and choose den sites on the basis of existing structure, which is not limiting in Maine. Dens can be located in alder swamps, spruce-fir thickets, regenerating clearcuts, partial cuts or mature stands of hardwoods or softwoods. Bears use cavities in the root masses of wind thrown trees or within standing trees as dens, and they dig into dirt mounds, crawl under brush piles, create ground nests of twigs or grasses in thickets, or den in rock cavities (Hugie 1982, Schooley 1990).

Interactions With Other Species

Black bears can be important predators on newborn young of deer, moose, caribou and elk (Schlegel 1976, Franzmann et al. 1980, Adams et al. 1988, Ballard 1994). The role of bear predation in limiting or regulating populations of moose or deer continues to be debated (Boutin 1992), and probably depends on the density of bears in relation to the number and density of other predator and prey species (Ballard 1994). Black bear predation on young calves is considered the major limiting factor for low density moose populations (Gasaway et al. 1992), and several studies have documented

black bears killing 2-50% of moose calves (see summary in Ballard 1994). Rogers et al. (1992) estimated that 2 black bears in Minnesota killed or scavenged 10% of the white-tailed deer fawns that were born within the bears' home ranges.

Black bears are known to kill moose calves and deer fawns in Maine, but the impacts of these losses on the State's moose and deer populations have not been studied. If bears affect deer populations in a manner similar to that documented for moose, they would have the greatest impact in northern and eastern Maine, where deer densities are low (Lavigne 1999).

Bear-human interactions are often characterized by conflicts over space or food sources. Most complaints about bears causing damage or nuisance problems occur during the spring and summer months (MDIFW file data). This is often a period of food stress, particularly when droughts reduce the growth of vegetation and the abundance of berry crops.

Residential development, land clearing for agriculture, and increased road densities associated with growing human populations have altered and fragmented bear habitat throughout the East (Hellgren and Maehr 1993). As humans develop and occupy bear habitat, bear-human conflicts (i.e., damage/nuisance, bear-vehicle collisions) increase, and bear survival usually declines (Hellgren and Maehr 1993). Bear-vehicle collisions have become a major mortality factor in some mid-Atlantic states, and some bears have demonstrated an avoidance of roads with high traffic volumes (Wooding and Maddrey 1994). However, few bears are killed on roads in rural states such as Maine, which have low human population densities and few high-speed highways. Maine's Department of Transportation recorded 50 accidents involving bears during 1996-1997 (R. Baker, MDOT report 1999). MDIFW records do not reflect a complete accounting of bears killed to control damage, but, in recent years, less than 50 bears are estimated to be killed annually (H. Hilton, ADC Coordinator, pers. comm.).

Reproduction

Bears are slow to reach sexual maturity, and have a low reproductive potential. In Maine, females produce their first litters at 4-6 years of age (Hugie 1982, McLaughlin et al. 1994, McLaughlin 1998). A female's first litter is usually 2 cubs, and subsequent litters average 3 cubs (McLaughlin 1998). Females enter estrus in May-June, with breeding season lasting through July-August (Alt 1989). Bears have delayed implantation[1] and fetal development, and the young are born from late December-February (Pelton 1982, Alt 1989). Newborn cubs weigh about 12 ounces (Alt 1989), are nearly hairless, and depend on their mother's warmth and milk for survival within the den. Family groups den together the following winter, and remain intact for 14-18 months (Alt 1977, Rogers 1987). Consequently, individual females generally produce successive litters at 2-year intervals. Early loss of a litter may short-circuit the cycle and allow consecutive-year litter production (McLaughlin 1998).

Reproduction is controlled by the nutritional condition of the female during fall. If female bears are unable to obtain sufficient food to reach a threshold weight, they rarely produce offspring that winter (Rogers 1987, Elowe 1987, McLaughlin 1998). Males may become sexually mature as young as 18 months, but probably do not participate in breeding until they attain full stature (4-5 years in Maine).

Cub production has become synchronized in northern Maine, due to regular, alternate-year shortages of late fall food (e.g., beechnuts)(Schooley 1990, McLaughlin et al. 1994, McLaughlin 1998). From 1982-1997, 124 of 132 litters (94%) examined in the region were produced on odd-numbered years (i.e., 1999), following abundant beechnut crops. During years of beechnut scarcity, most adult females entered dens with little stored body fat, and only 15% of the few females that were in breeding condition produced cubs.

Behavior

Black bears have a social system that changes with season and food availability. They are solitary most of their lives, except for breeding pairs in the summer months, and females accompanied by dependent young. Adult males (4 years of age and older) often dominate food sources, and adults are known to prey on smaller bears. However, black bears do not actively defend territories. When food is abundant, they tolerate other bears in close proximity at food patches. Black bears use large areas; in Maine, ranges of females are 6-9 mi^2, and males use areas up to 100 mi^2 or more (Hugie 1982, Lamb 1983, MDIFW file data). Ranges overlap and are shared among bears of different ages and sexes. In most hunted populations there is little direct conflict among bears, except during breeding season.

Black bears will occasionally kill and cannibalize other bears. Most cannibalization documented in Maine has been on subadult bears (2-3 years of age) during spring and summer, although 1 entire family group (female with newborn cubs) was killed and eaten by a larger bear in early spring (MDIFW file data). Although large males are presumed to do most killing of other bears, adult females also kill and eat others (various studies cited by Garshelis 1994).

Female bears remain within or close to the area they were born in, but males disperse as subadults, usually at 2-4 years of age in Maine (Hugie 1982, MDIFW file data). Males often disperse up to 50 miles; eartagged bears from Maine have been killed or captured in Quebec and New Brunswick. These long-distance movements, and the tendency for males to use large home ranges, contributes to lower survival of male bears, as they have more frequent interactions with humans.

Bears will travel 40-50 miles to exploit distant food sources, such as stands with concentrated berry or nut crops, or fields of agricultural crops (Hugie 1982, Schooley 1990). They have a well-developed homing instinct, and commonly

travel outside of their annual ranges for short periods (up to 4 weeks) during the late summer or fall months (Alt 1977, Hugie 1982).

Bears are most active in early morning and late afternoon-evening hours (Garshelis and Pelton 1980). Their activity levels increase in fall, as they begin an intensive foraging period in preparation for winter. In Maine, bears stop feeding and enter dens by mid-late October when nut crops fail (Hugie 1982, Lamb 1983, Schooley 1990, McLaughlin 1998). When fall food is abundant, they will forage until late November- early December, or until snow depths make travel and feeding difficult. Bears may spend up to 6 months of the year in winter dens in Maine, emerging during April. They rarely feed during the first 2 weeks after leaving their dens, as their bodies undergo the shift from winter dormancy to spring activity (Folk et al. 1972).

Survival and Cause of Death

Although black bears are long-lived mammals capable of surviving for 25 years or more in the wild (McLaughlin 1998), few bears in a population ever reach 10 years of age (Pelton 1982). With few natural predators, black bear survival is governed by food supply and man's activities (Pelton 1982, Miller 1990, Garshelis 1994). Malnutrition (Rogers 1976, Elowe and Dodge 1989), and cannibalism (Young and Ruff 1982, LeCount 1987, Schwartz and Franzmann 1991, Higgins 1997) may be significant causes of cub and yearling mortality, with cannibalism remaining an important mortality factor for yearlings and subadults (Rogers 1976, Garshelis 1994). Humans become the principal mortality agent for subadult and adult bears through hunting, collisions with vehicles, and lethal removal of bears in conflict with human activities (Rogers 1976, Bunnell and Tait 1985, Garshelis 1994, Higgins 1997). In Maine, adult females survived periods of scarce food that sometimes caused starvation of yearlings and subadults (2-3 years of age)(MDIFW file data). Much of the food energy obtained by young bears is used to fuel body growth, and therefore less is available to maintain condition. Adult females may forego reproduction to utilize critical stores of body fat for their own survival following fall food failures (Rogers 1976, Elowe 1987, Kolenosky 1990), but it is rare for adults to die from starvation (Noyce and Garshelis 1994, McLaughlin 1998; Table 1). During the winter months, when bears are in dens, adults exhibit very high survival, approaching 100% (Rogers 1987). In Maine, winter survival of yearlings and subadults dropped as low as 86% and 91%, respectively (McLaughlin 1998).

Although males generally have lower survival rates than females (Elowe 1987, Schwartz and Franzmann 1991), survival of both sexes increases as bears mature (Bunnell and Tait 1985, Elowe and Dodge 1989, McLaughlin 1998). In Maine, cubs experience 58-83% survival their first year of life (McLaughlin 1998). By the time female bears are adults (4 years of age), their survival increases to nearly 100% in the absence of hunting.

In Maine, most deaths of bears over 2 years of age are recorded during the fall hunting season (Table 1). Cubs and yearlings die more frequently from natural causes, including starvation, during the spring and summer months (Table 1; McLaughlin 1998). The State's bear range has relatively few high-volume, high-speed highways, and few bears die from collisions with vehicles. Only 3% of 436 recorded deaths of bears that were eartagged on 3 study areas in central and northern Maine were caused by collisions with vehicles (Table 1), and none were killed as nuisances (McLaughlin 1998).

Disease does not appear to play a major role in the regulation of bear populations (Pelton 1982). Bears in Maine are susceptible to a variety of parasites, primarily round worms and ticks (MDIFW file data). Tumors are rare (MDIFW file data), and the incidence of trichinosis is low (G. Matula, personal comm.). Rabies is extremely rare in bears, and there are no records of rabies occurring in bears in Maine. Dental problems, including caries (cavities) and broken and missing teeth associated with advanced age, are the most common diseases of Maine bears (MDIFW file data).

Table 1. Cause of death of black bears studied in Maine, 1981- 1996.[a]

Study Area	Sex	Age Class	Hunting	Crippling	Auto	Disease/ Research	Starvation	Other	Bear	Unknown	Total
Spectacle Pond	Female	Cub	2	0	0	0	0	0	2	30	34
		Yearling	9	1	0	3	5	1	1	0	20
		Subadult	19	3	0	2	2	0	4	0	30
		Adult	44	0	0	5	0	1	2	1	53
		Combined	**74**	**4**	**0**	**10**	**7**	**2**	**9**	**31**	**137**
	Male	Cub	5	0	0	1	0	0	2	28	36
		Yearling	4	0	0	0	2	0	1	0	7
		Subadult	47	0	0	0	0	0	0	0	47
		Combined	**96**	**0**	**1**	**1**	**2**	**0**	**3**	**28**	**131**
Stacyville	Female	Cub			0	0	0	0	0	7	7
		Yearling	0	0	0	2	2	0	0	1	5
		Subadult	5	0	0	2	1	0	0	0	8
		Adult	6	1	0	0	0	0	0	0	7
		Combined	**11**	**1**	**0**	**4**	**3**	**0**	**0**	**8**	**27**
	Male	Cub	0	0	0	0	0	0	0	7	7
		Yearling	9	0	0	0	0	0	0	0	9
		Subadult	10	0	0	0	0	0	0	0	10
		Adult	10	0	0	0	0	0	0	0	10
		Combined	**29**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**36**
Bradford	Female	Cub	1	0	1	3	2	0	0	19	26
		Yearling	11	0	0	6	2	0	0	1	20
		Subadult	14	1	2	4	1	0	1	1	24
		Adult	17	1	1	2	1	0	1	0	23
		Combined	**43**	**2**	**4**	**15**	**6**	**0**	**2**	**21**	**93**
	Male	Cub	3	0	0	5	0	0	1	22	31
		Yearling	7	0	1	0	0	0	1	0	9
		Subadult	59	0	2	1	0	0	0	0	62
		Adult	23	1	3	0	0	0	0	0	27
		Combined	**92**	**1**	**6**	**6**	**0**	**0**	**2**	**22**	**129**

[a] Cause of death--for cubs (either sex): determined by in-den counts of newborns and yearlings; -- for yearlings and older: telemetry studies for females, and ear tag returns for males

MANAGEMENT

Regulatory Authority

The State Legislature has retained authority to regulate bear populations, although much of the practical aspects of regulation have been transferred to the Department of Inland Fisheries and Wildlife (MDIFW). The Legislature still sets the season dates within which hunting and trapping is permitted, and specifies legal methods of take, bag limits, and license fees. The Commissioner of MDIFW and his Advisory Council have latitude in controlling bear harvests. They determine the time that particular hunting and trapping methods are permitted, and are also able to define legal hunting implements and hunting hours. The Commissioner's actions are governed by Maine's Administrative Procedures Act, which mandates a public comment period on all regulatory actions before they are implemented.

In 1990, the Legislature established a bear permit system, requiring hunters to possess a bear permit in addition to a big game license when hunting bears. Bear permit fees have ranged from $3 (1990) to $6 (1999) for residents, and from $11 (1990) to $16 (1999) for nonresident hunters. This additional licensing provision allows the Department to determine how many hunters specifically pursue bears in the State, and to assess hunting effort and success. The permit requirement is waived during the last 4 weeks of the 13-14 week bear season, which runs coincidental to the November firearms deer season. Bears have been regarded as a bonus quarry by many deer hunters, who are opposed to paying extra fees to hunt bear incidentally while they pursue deer. In addition, the chances of deer hunters taking bear in the firearms deer season are strongly influenced by the dates that bears enter dens each fall. When food is scarce, bears often enter dens in mid-late October, before deer season. They remain active through late November if late fall food is abundant. Consequently, the success rates of November bear hunters can fluctuate dramatically with little relationship to the size of the bear population.

Past Goals and Objectives

The first bear management goal was established in 1975, which was to maintain bear abundance, distribution, and use at pre-1974 levels. The accompanying harvest objective was to provide annual harvests of 800-1,000 bears statewide, with harvests in each Wildlife Management Unit (WMU) limited to less than 15% of the Unit's minimum estimated bear population. The bear management goal remained unchanged in 1980.

In 1985, the goal was updated — to maintain the population at 1985 levels, which was estimated at 21,000 bears statewide. Associated abundance objectives were to maintain prehunt population densities at 0.8 - 1.3 bears/mi^2 in WMU's 2 and 5 (approximately WMD's 1, 2, 4, 5, 9, 10, southern half of 11, eastern half of 18, and 19) and at 0.5-0.7 bears/mi^2 in WMU's 1, 3, 4, and 6, (approximately WMD's 3, 6, 7, 8, northern half of 11, eastern half of 26, 27, 28, 29) and 0.2-0.5 bears/mi^2 in WMU 7 and 8 (approximate WMD's: 16, 20, 21, 22, 23, 25, western half of 26) (Figure 1). The harvest objective was revised — to increase harvests to 1,500-2,500 bears statewide, or levels needed to stabilize the population. This management goal and associated objectives have governed the Department's bear management through 1999.

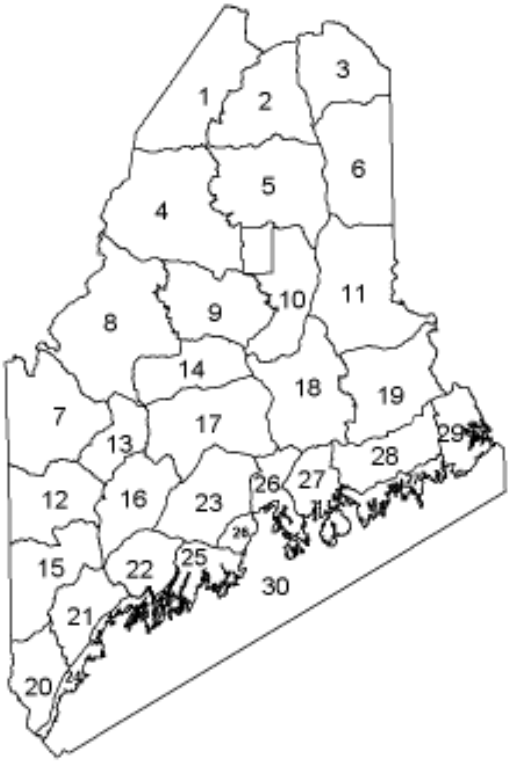


Figure 1A. Wildlife Management Districts.

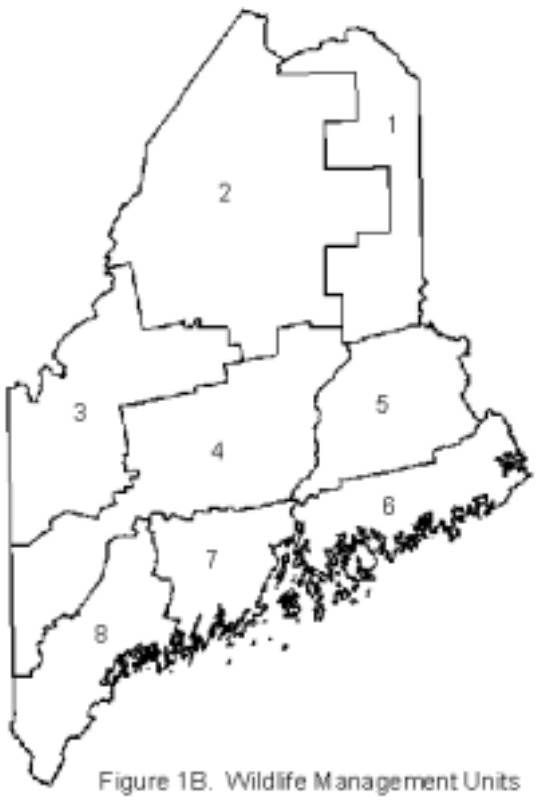


Figure 1B. Wildlife Management Units

Past Management

The earliest efforts to manage bears were township-level bounties to reduce bear depredations on agriculture. The first bounty on bears was offered by the town of Scarboro in 1770, and bounties were offered in parts of Maine most years from 1880 through 1957 (Table 2). Bears were not protected by a closed season until 1931, when the legislature classified them as game animals and instituted a short open season that ran coincidentally with the fall deer season. This protection was in effect for 10 years, even though bounties continued on bears in northeastern and southern Maine. By 1942, bears were once again legal game year round. The next protection they were offered was in 1966, when a June 1 - December 31 season was enacted. A bag limit of one bear/hunter/year was first imposed in 1969, the same year that mandatory registration of harvested bears was required, cubs were protected, and cable traps were legalized for trapping.

Cubs became legal game in 1971, and minor changes in season dates occurred during the next few years, although bears were essentially hunted during most of the period that they were not in dens (May - November). The 1970s marked greater efforts to monitor the bear population, and the Department began its bear study in 1975 to provide data for management. Rapidly increasing harvests in the late 1970s led to a series of actions to reduce harvest levels and maintain bear numbers. The Commissioner ordered an emergency closure of the bear season in September 1980 (Table 2), after the season harvest (through November) was projected to greatly exceed the management objective of 800-1,000 bears. In 1981, legislative action created two separate bear seasons, held in the spring and fall. By 1982 a fall-only season framework was in place, and no spring seasons have been held since.

The Wildlife Division sampled the ages of harvested bears during the 1970s through voluntary collections of premolar teeth from guides and hunters. Mandatory submission of premolars from hunter-killed bears was in effect from 1981 through 1986. These tooth collections allowed Department biologists to determine the age distribution of the harvest. The tooth age collection was dropped because no direct relationship had been established between changes in the age distribution of the harvest and concurrent changes in the composition and status of the bear population. Increased restrictions on the timing and placement of bear bait, and on the timing and areas open to training hounds on bear, became law in 1987.

Current Management

Bear management has remained relatively constant since 1990, with only minor changes in harvest regulations. Harvest regulations continue to be applied uniformly statewide, with no regional differences despite WMU-specific abundance objectives. Current season dates resulted from concern over sustained growth in bear harvests during 1986 -1989, which exceeded the objective of 1,500-2,500 bears. The large harvests were primarily due to greater participation in hunting over bait. In 1990, the bait hunting period was reduced from 9 weeks to 4 weeks, opening in late August (Figure 2). Hunting with hounds was restricted from 9 weeks to 6-7 weeks starting in mid-September, and still-hunting/stalking was reduced from 13-14 weeks to 4 weeks during the firearms deer season in November. Lastly, the trapping season was shortened from 9 weeks to a 4-week period encompassing October. To minimize conflicts between hunters using bait and hunters pursuing bears with hounds, the opening date of the houndsmen's season was delayed, opening 2 weeks after bait season began. The Department also removed the trapping period from the baiting season in response to concerns about the illegal use of traps near hunters' baits.

These season changes were designed to minimize restrictions on hunting opportunity, while ensuring that annual harvests would be conservative enough to maintain the population at 21,000 bears. The Department has used an interim harvest objective of less than 2,300 bears per year since 1990 to promote positive population growth, following the population decline in the late 1980s.

A few lesser changes in season structure have occurred since 1990. The baiting and houndsmen's hunting periods have remained unchanged, but both the period of still-hunting/stalking and the trapping season were expanded. Beginning in 1994, still-hunting and stalking were allowed throughout the 3-month bear season, and the trapping season was expanded from 4 weeks to 5 weeks in length. In 1997, the trapping season was extended to its pre-1990 length of 2 months (September and October). Few bears are harvested by still-hunting/stalking prior to November, or by trapping. Consequently, liberalization of harvesting opportunity for these methods of take had little effect on overall harvest levels (Figures 2, 3; Table 3).

Table 2. Bear management history in Maine.

		Estimated effort	Status and Regulations		
Year(s)	Harvest	(# hunters)	Season length	Bag limit	Remarks
1770	no records	no records	no closed season	no limit	Bounty paid in Scarborough.
1880s	bounty payment (incomplete)	"	"	"	Bounties paid in various parts of the state.
1931-41	bounty payment (incomplete)	"	same as deer season		
1941-57	1,569[1]	"	no closed season	"	Bountied.
1943		"	"	"	Hunting prohibited on Sundays and at night.
1952-53		"	"	"	Study on status of bears in state completed (Spencer, 1955).
1957		"	"	"	Bounty repealed.
1958-65		"	"	"	Only partial kill figures exist from 1958-68.
1963		"	"	"	Mandatory reporting of all bears killed.
1966-68		"	June 1-Dec. 31	"	
1967		"	"	"	Trapping season restricted to June 1-Dec. 31.
1969	806	"	"	1/hunter/yr	Cubs protected, cable traps legalized, mandatory registration of all harvested bears after Oct. 1, 1969.
1970	970	"	"	"	
1971	989	31,358	"	"	Cubs become legal game.
1972	786	31,110	"	"	
1973	1,078	34,444	June 1-Nov, 24	"	
1974	751	24,146	May 1-Nov. 30	"	
1975	959	26,985	"	"	Intensive study of exploitation, movements, and habitat selection begun.
1976	1,008	23,296	May 1- Saturday following Thanksgiving		
1977	1,066	22,244	"	"	
1978	1,320	21,021	"	"	
1979	1,630	22,665	"	"	
1980	1,058	9.658	May 1-Sept 13	"	Hunting season truncated on Sept. 13 by Commissioner to limit harvest size.
1981	1,001	24,518	May 1-June 13; Oct. 1-Nov. 28		Mandatory submission of premolars for aging purposes.
1982	1,221	33,417	Sept 1-Nov 30	"	
1983	1,412	33,545[2]	"	"	
1984	1,601		"	"	
1985	1,544		"	"	
1986	1,955		"	"	Repealed mandatory submission of premolars.
1987	2,394		"	"	New baiting restrictions, and dog training seasons go into effect.
1988	2,673	20,676[3]	Aug 29-Nov 30	"	
1989	2,690		Aug 28-Nov 30	"	
1990	2,088	11,803[4]	Aug 27-Nov 30	"	Additional restrictions on length of time baiting, use of dogs, and still hunting/stalking. Trapping permitted during Oct 1-Oct 31.
1991	1,665	10,204	Sept 2-Nov 30	"	
1992	2,042	10,133	Aug 31-Nov 28	"	
1993	2,055	10,195	Aug 30-Nov 27	"	
1994	2,243	9,991	Aug 29-Nov 26	"	Trapping period extended to 5 weeks, still Hunting/stalking extended to entire season.
1995	2,645	10,929	Aug 28-Nov 25	"	
1996	2,246	10,928	Aug 26-Nov 30	"	
1997	2,300	10,669	Aug 25-Nov 29	"	Trapping period extended to Sep 1-Oct 31.
1998	2,618	10,871	Aug 31-Nov 28	"	

[1] Mean calculated kill 1946-59.

[2] Estimated number of bear hunters, based on Dept. Inland Fisheries & Wildlife, personal hunting report (game kill questionnaire). The game kill questionnaire was sent to a sample of licensed hunters annually. The resulting estimate of bear hunter numbers was likely inflated and includes hunters who pursued bears during deer season.

[3] Estimted based upon the 1988 survey of bear hunters (Reiling er al. 1991)

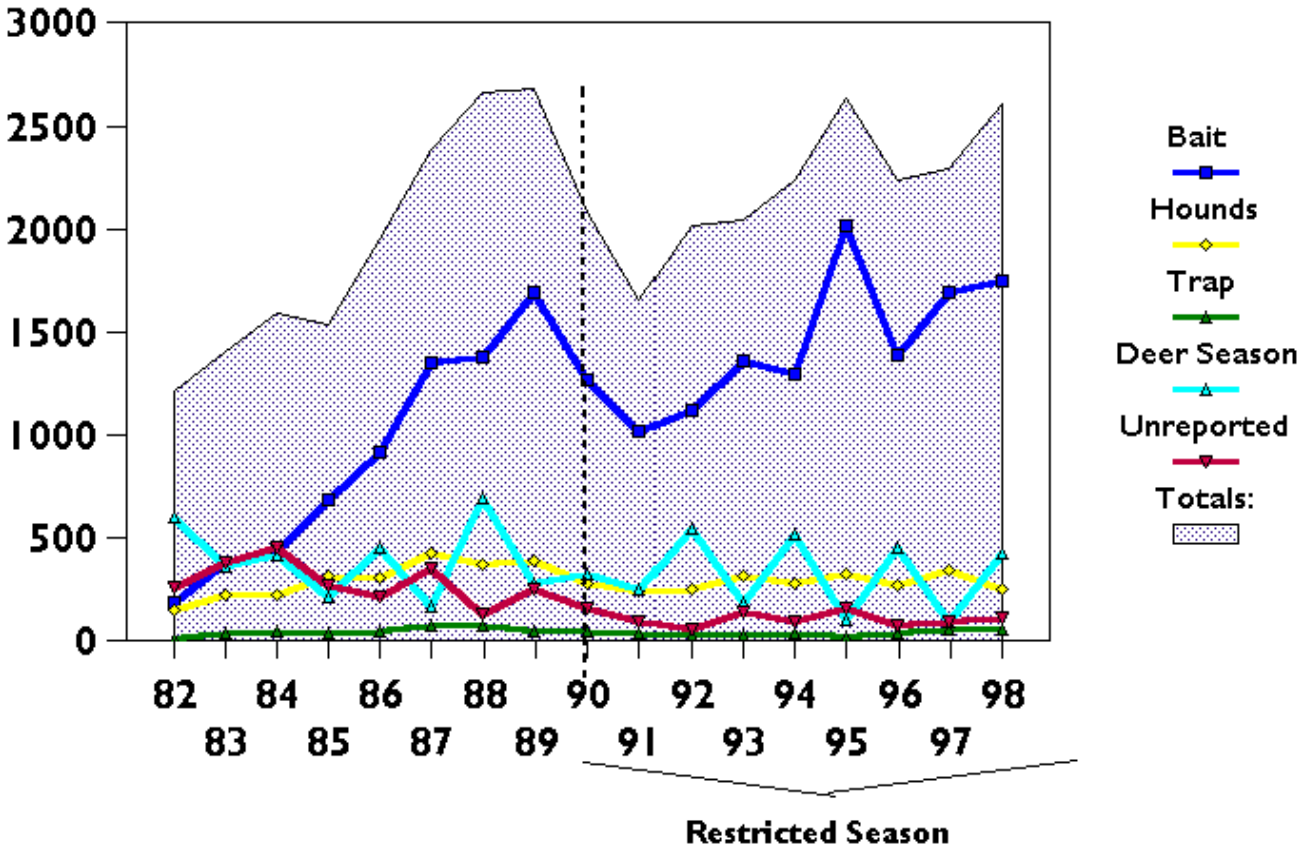
[4] Since 1990, the actual number of bear hunting permits sold. A bear permit is only required for hunting bears prior to firearms deer season opening, which is usually about November 1.

Table 3. Bear harvest by method of take, 1982-1998.

Year	Method of Take					Totals
	Bait	Hounds	Trap	Deer Season	All Other Methods[1]	
82	187	152	12	603	267	1,221
83	386	231	43	366	386	1,412
84	443	230	47	422	459	1,601
85	687	322	45	214	276	1,544
86	920	311	52	456	216	1,955
87	1,358	428	77	174	357	2,394
88	1,387	374	75	701	136	2,673
89	1,698	397	55	281	259	2,690
90	1,277	287	50	325	158	2,088
91	1,027	241	40	256	94	1,658
92	1,123	257	32	551	62	2,025
93	1,364	316	35	193	147	2,055
94	1,297	282	45	524	95	2,243
95	2,020	329	25	110	161	2,645
96	1,398	273	41	458	76	2,246
97	1,701	344	56	101	98	2,300
98	1,755	258	59	429	117	2,618

[1] All other legal methids include still hunting, stalking, incidental to deer, bird hunting.

Figure 3. MAINE BEAR HARVESTS BY METHOD OF TAKE 1982-1998



HABITAT ASSESSMENT

Past Habitat

The black bear is associated with forested areas throughout most of North America, and historical trends in the amount of forestland in Maine can be used to describe gross changes in bear habitat over time. Beginning with the time of European settlement and lasting into the late 1800s, forestland declined steadily with the expansion of agriculture. Land clearing for farming was prevalent in coastal regions, and spread up the major river drainages through central and western Maine. Most agricultural operations in northern Maine were limited to the northeastern portion of Aroostook County, along the St. John River valley. At the height of land clearing in 1880, only 68-78% (13-15 million acres) of the State remained forested. Changes in agricultural practices and farm abandonment led to an expansion of forestland over the past 120 years. By 1950, about 80-82% of Maine was forested, and by 1982 about 89% of the State was in forestland (Powell and Dickson 1984).

In addition to changing the quantity of bear habitat in Maine, human use of the land has influenced the quality of bear habitat. Efforts to farm much of central and northern Maine nearly a century ago, and widespread industrial forest practices in recent years have combined to generate an unprecedented change in much of northern Maine's forests, greatly improving habitat quality for bears over the last 25 years.

Forests that regrew on previously-farmed areas probably created higher quality bear habitat than forests that originally covered the region. Apple trees continued to produce fruit for decades on abandoned farms, and grasses, forbs, and berry-producing shrubs and trees, that grew in reverting cropland and meadows, were used by bears.

The industrialization of Maine's northern forestlands also affected bear habitat, primarily in the last 30 years. Mechanized tree harvesting and associated road building has created a mosaic of smaller stands of various ages and species composition, interspersed with small open areas. The greater interspersion of vegetative types probably improved habitat for bears by providing seasonal foods in close proximity. In general, the State's forests have become more hardwood-dominated (Chilelli 1998, Gadzik et al. 1998), and stands regenerating in the aftermath of logging for pulpwood produce more food for bears than the mature softwood stands they replaced. Roadsides and log landings are persistent openings that are often seeded with herbaceous plants to control erosion. These areas provide a variety of early spring and summer foods (i.e., grasses, forbes, berries, and colonial insects).

Compared to the widespread influences of agriculture and forestry, urbanization and residential development have not significantly affected the State's bear habitat. Maine's human population expanded from about 850,000 in 1940 to about 1.2 million in 1990 (USBC 1990), but most human population centers are located in south-central regions, along the edge, or outside of, occupied bear range.

In 1975, bear habitat was estimated at 22,775 mi^2, or 71.4% of the State's inland area (Hugie 1975). This estimate was derived by adding the area in suitable woodlands and usable wetlands to 10% of the area in idle and active farmland (Appendix I); unfortunately, no definition of suitable woodland (the dominant habitat category) was given. The 1980 bear assessment retained the 1975 estimate of bear habitat.

During the 1985 assessment, the amount of bear habitat was estimated at 25,850 mi^2, based upon the 1980 Maine Forest Resurvey (USFS 1982) (Appendix I; McLaughlin 1986). Bear habitat was defined as all forestland in WMU 1-6, 65% of the forestland in WMU 7, and 50% of forestland in WMU 8. Portions of the forestlands in WMU 7 and 8 were excluded from bear range because much of the forested areas in these units occur as small, dispersed wood lots that were considered unsuitable for bears. Because different criteria were used to estimate the amount of bear habitat in 1975 and 1985, changes over time could not be measured.

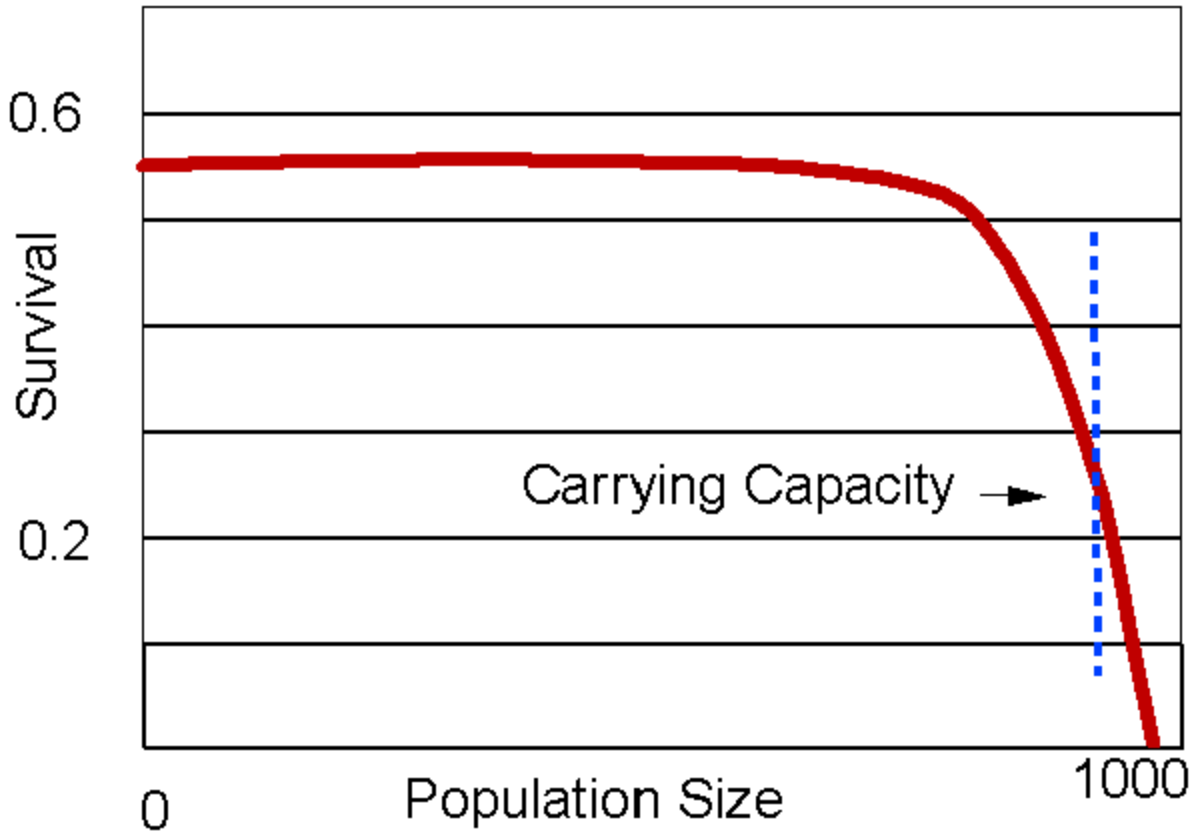
Habitat quality was only evaluated in a general sense in both 1975 and 1980, using human activity levels and the amount of forest in mature or nearly-mature coniferous forest as indicators of habitat suitability for bears (Hugie 1975, Hugie 1980). Although WMU 2 was judged to be most suitable for bears, no additional ranking of regional habitat conditions was included in these assessments. In 1985, a Habitat Suitability Index (HSI) (McLaughlin 1986) was developed and applied to Maine's bear habitat, using the 1980 Maine Forest Resurvey (Powell and Dickson 1982) and the Habitat Evaluation Process (HEP) (Schamberger and Krohn 1982). The HEP approach to habitat assessment relies on knowledge of the life requisites of bears and measurable biological and physical characteristics of the State's landscape. Habitat quality within each WMU was rated on a scale of 0 - 1.0, with a value of 0 representing habitat conditions unsuitable for bears, and a value of 1.0 representing optimum habitat conditions (Appendix I).

Bears are not known to negatively influence the capacity of the land to support them, through changes in vegetational structure. Within this assessment, the term carrying capacity is defined as the maximum density for bears that a unit of land area can support. The density figures used in this document refer to bear densities during the spring season, which is the season of greatest density on an annual basis.

There is little evidence that bear populations are regulated by internal factors, such as behavior that controls spacing of individuals, or declines in reproductive success. It is more likely that they are limited by their food supply, which may control age of sexual maturity, proportion of adult females that reproduce, and survival of bears (primarily cubs, yearlings, and subadults) (Taylor 1994, McLaughlin 1998). Density-dependent changes in the vital rates of bear populations probably only occur when population levels are very close to carrying capacity (Figure 4). Acknowledging these

limitations, the statewide carrying capacity for bears was estimated at 33,000 bears in 1985 (McLaughlin 1986). The statewide carrying capacity was developed using the HSI, assuming that optimum habitat in the Northeast could support 1.5-2 bears/mi^2 (McLaughlin 1986). Little information was available to project habitat changes from 1985 through 1990, but a 10% reduction in carrying capacity (30,000 bears by 1990) was adopted as a reasonable estimate for planning purposes. This projection assumed the amount of forestland would remain nearly constant during the period. However, it also assumed that habitat quality would decline due to a loss of mature hardwood stands through timber harvesting, and greater conflicts between bears and an expanding human population.

Figure 4. Example of Nonlinear Reduction in Survival



Current Habitat

In this assessment, bear habitat is described using a new system of 30 ecologically based Wildlife Management Districts (WMDs), adopted by MDIFW in 1998 (Figure 5). Forest composition is described based upon the 1995 Maine Forest Resurvey (USFS 1997, Chilelli 1998). The amount of forestland used as a basis for quantifying bear habitat was obtained from the vegetation and landcover map used in the Gap Analysis of Maine (Hepinstall et al. 1999, Krohn et al. 1998) - modified to incorporate all National Wetland Inventory polygons. Potential bear habitat, measured for each WMD, was considered to include all categories of forestland and 5 categories of forested/shrub-scrub wetlands measured by remote sensing (Appendix II). The 1985 habitat assessment was based upon larger geographic units (WMU's) with different boundaries (Figure 1), and Maine Forest Resurvey estimates of area by forest covertypes (Powell and Dickson 1984). Therefore, only general comparisons can be made between present habitat conditions and those in 1985.

Regular, alternate-year scarcities of beechnuts are associated with an alternate-year reproductive synchrony in northern Maine, where most cubs are produced on odd-numbered years (i.e., 1995,1997, 1999; McLaughlin et al. 1994, McLaughlin 1998). This strong relationship occurs in regions where bears are limited to beech mast as their major fall food source; bears in central Maine have more diverse fall diets and produce more consistent annual cub crops (McLaughlin 1998). To account for these regional differences in bear reproduction and food availability, the State was divided into 3 regions for habitat assessment (Figure 5). The Forest Region is a group of 11 WMDs (and Baxter State Park) with similar characteristics that represents the expansive contiguous forestlands in northern Maine. Bears in the Forest Region are largely restricted to beechnuts as their primary late-fall food source; this area has very little agricultural land, and few oaks, hazelnuts, or trees or shrubs producing persistent fruit. The Forest-Farm Region comprises 17 WMDs that encompass much of the remainder of the State's inland area, where bears have access to agricultural crops and/or a wider range of fall foods. The Unsuitable for Bear Region includes WMD 24 in extreme south coastal Maine, and WMD 30, which represents coastal islands. Both WMDs have high human populations and fragmented forests that are largely unsuitable as bear habitat.

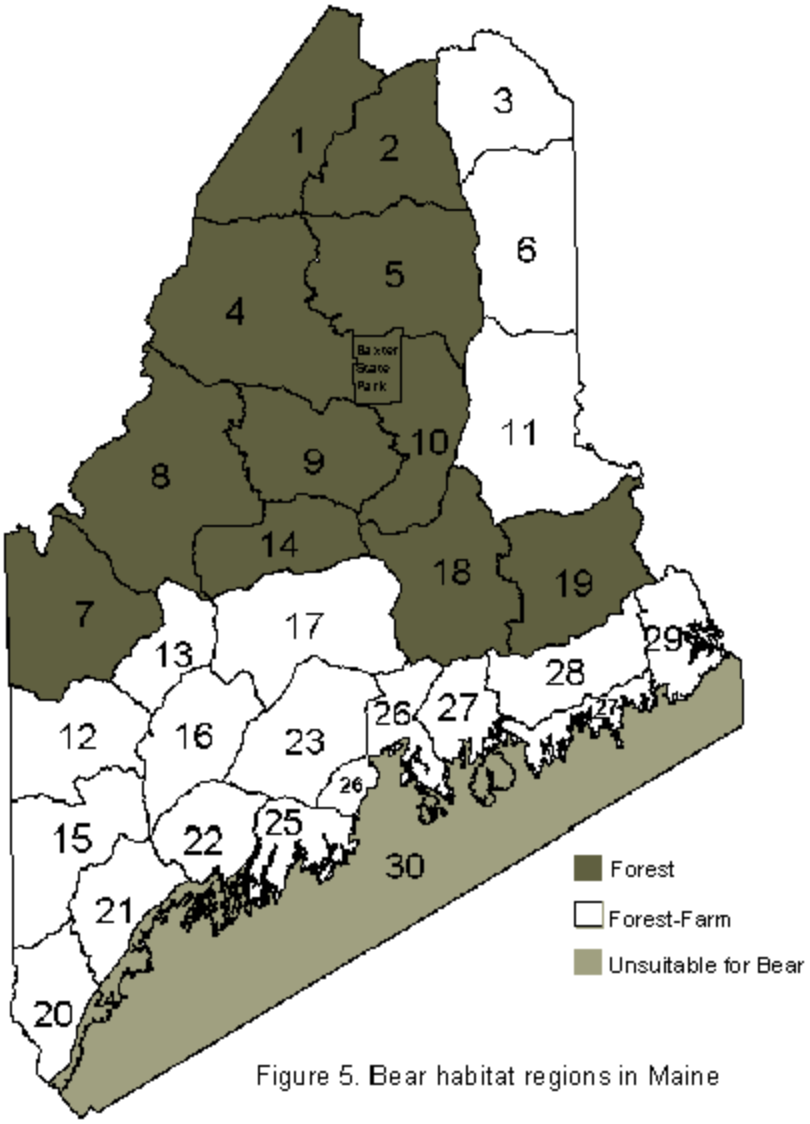


Figure 5. Bear habitat regions in Maine

Since 1982, the quantity of forestland in Maine has remained virtually unchanged, as gains in some regions were offset by losses in others (Griffith and Alerich 1996). Spruce-Fir acreage has declined nearly statewide, in association with the conversion of softwood forests to hardwoods, as a result of hardwoods outcompeting softwoods in regenerating clearcut, and the selective harvesting of spruce and fir during spruce budworm salvage operations during the 1980s (Chilelli 1998). However, it is uncertain whether this decline in spruce-fir forest acreage and associated expansion of hardwood forests will continue during the next 20 years (Chilelli 1998), as forestry practices are changing. Current timber harvest methods are encouraging the development of softwood forest types, and increased harvesting of mature hardwood stands should reduce the abundance of large, nut-producing hardwoods, primarily beechnuts (Chilelli 1998). The 1995 Forest Resurvey indicates that beech has increased in prevalence in Maine since 1982, with a slight decline in size class (Griffith and Alerich 1996). Statewide, potential bear habitat is estimated at 26,973 mi^2, with 14,452 mi^2 in the Forest Region and 12,521 mi^2 in the Forest-Farm Region (Table 4).

Present habitat suitability was evaluated by applying updated Maine Forest Inventory data (MFI) (USFS 1997) and modified Maine Gap data (Hepinstall et al. 1999, Krohn et al. 1998) to a revised version of the HSI (Appendix III; McLaughlin et al. 1988; Appendix II). The HSI values were computed for each of the 2 bear habitat regions (Forest and Forest-farm), as MFI sampling was too sparse to provide reliable estimates of several parameter values for smaller geographic units (i.e., WMDs). Bear habitat quality was rated highest in the Forest (HSI = 0.82) and slightly poorer in the Forest-Farm Region (HSI = 0.72) (Table 4). These values are comparable to the HSI values assigned to the State's bear habitat in 1985 (Appendix II). Overall habitat suitability in the Forest was limited by the value of food variables, and cover suitability values limited habitat suitability in the Forest-Farm Region.

Maine's carrying capacity for bears is estimated at 36,515 bears (range 31,299 - 41,732) (Table 4). Slightly greater than half of this carrying capacity (20,739 bears) is attributed to the Forest Region; the Forest-Farm Region's carrying capacity is estimated at 15,776 bears. These estimates of habitat and carrying capacity differ from the 1985 assessment, and they are not directly comparable. Both the data and assumptions used to describe bear habitat differ between 1985 and 1999. In particular, the amount of suitable bear habitat in south central and western Maine (WMU's 7 and 8) were estimated using GIS coverages in 1999 (Appendix II). This technology was not available in 1985 and consequently the earlier estimate of bear habitat in that region was overly conservative.

Habitat Projection

In the future, portions of Maine's bear habitat will probably be altered as much by recreational and residential development as by traditional forest practices. Greater human presence and recreational development in western Maine and expansion of urban areas along the periphery of bear range in southern and central regions are changing the character of bear habitat. Black bears are able to live in close proximity to humans, as long as dense cover is available for escape and seclusion, and human residents tolerate conflicts with them.

The primary habitat change in the Forest Region may be a reduction in the amount of beechnut mast for bears. Accelerated logging of hardwood stands could reduce the number of mature, nut-producing beech trees on the landscape, given expected market conditions that favor continued use of hardwood species. However, some foresters have been receptive to recent efforts by the Department that promote retention of mature beech trees as important wildlife food sources. Management guidelines for beech are being finalized (Wiley 1999), and some industrial forest landowners have entered into cooperative agreements with the Department to manage hardwood stands for future beech mast production. Although these cooperative efforts have produced positive results, they encompass only a small fraction of the acreage in hardwood stands, and loss of mature beech trees to timber harvest continues to be a management issue in much of northern Maine.

More problematic is the threat of widespread mortality of beech trees due to beech bark disease (Houston 1975). Although this disease has been known in Maine throughout the last century, the present age and size structure of hardwood stands may predispose them to an epidemic (Houston 1975). Most stands containing beech have infected trees, and high rates of tree mortality have been reported in northcentral Maine (D. Kane, pers. comm.). Most infected trees live and continue to produce mast for many years before dying from the disease. Little is known about how the disease impacts longevity of trees and production of beechnuts over their lifetimes. Therefore, the likelihood of a die-off of beech trees due to beech bark disease is questionable. This uncertainty of a widespread loss of beechnut crops makes projecting future habitat conditions in the Forest Region difficult. Continued monitoring of the status of forest stands containing beech trees, including mortality and beechnut production, is needed to ensure timely management action if a die-off occurs. In any event, beech mast abundance in the Forest is more likely to decline than to increase.

Without a fall food source that replaces beechnuts, the population's rate of cub production will drop, and the mean age of bears in the population will increase as fewer young bears are recruited into adult age classes. If a disease-driven catastrophic loss of beech trees did occur, both the carrying capacity of the region's habitat and bear productivity would decline. Assuming this worst-case scenario, the HSI model projects that habitat suitability in the Forest Region would decline from the present value of 0.82 to 0.50. This drop in habitat suitability translates to a reduction in the region's carrying capacity to 12,646 bears, or 61% of present carrying capacity (Table 5). Annual harvests would have to be reduced substantially to maintain bear densities in the Forest Region close to present levels. Modeling simulations indicate that, in

Table 4. Present bear habitat suitability - 1999.

WMD	Bear Habitat Category	Land Area (sq. mi)	Percent Bear Habitat	Bear Estimated Bear Habitat (sq. mi)	Habitat Suitability index value	Carrying Number of Bear Habitat Units	Carrying Capacity (Number of Bears) High	Capacity (Number of Bears) Low	Mid Point
1	Forest	1,419.62	0.98	1,392.43	0.82	1,142	2,284	1,713	1,998
2	Forest	1,189.89	0.98	1,171.22	0.82	960	1,921	1,441	1,681
3	Forest-Farm	966.29	0.85	816.61	0.72	588	1,176	882	1,029
4	Forest	1,962.74	0.98	1,917.38	0.82	1,572	3,145	2,358	2,751
5	Forest	1,549.07	0.97	1,508.79	0.82	1,237	2,474	1,856	2,165
6	Forest-Farm	1,416.85	0.76	1,079.13	0.72	777	1,554	1,165	1,360
7	Forest	1,393.26	0.98	1,364.96	0.82	1,119	2,239	1,679	1,959
8	Forest	2,054.45	0.98	2,003.25	0.82	1,643	3,285	2,464	2,875
9	Forest	978.71	0.97	950.31	0.82	779	1,559	1,169	1,364
10	Forest	897.87	0.94	839.74	0.82	689	1,377	1,033	1,205
11	Forest-Farm	1,700.15	0.90	1,530.35	0.72	1,102	2,204	1,653	1,928
12	Forest-Farm	996.00	0.92	919.02	0.72	662	1,323	993	1,158
13	Forest-Farm	574.91	0.91	521.55	0.72	376	751	563	657
14	Forest	798.15	0.96	766.98	0.82	629	1,258	943	1,101
15	Forest-Farm	1,038.34	0.83	862.27	0.72	621	1,242	931	1,086
16	Forest-Farm	826.06	0.79	653.05	0.72	470	940	705	823
17	Forest-Farm	1,430.45	0.80	1,143.79	0.72	824	1,647	1,235	1,441
18	Forest	1,367.23	0.89	1,218.90	0.82	1,000	1,999	1,499	1,749
19	Forest	1,175.83	0.93	1,096.67	0.82	899	1,799	1,349	1,574
20	Forest-Farm	646.25	0.75	484.40	0.72	349	698	523	610
21	Forest-Farm	629.39	0.69	437.23	0.72	315	630	472	551
22	Forest-Farm	576.26	0.72	413.33	0.72	298	595	446	521
23	Forest-Farm	1,035.45	0.79	815.29	0.72	587	1,174	881	1,027
24	Unsuitable for Bear	373.65	0.00	0.00	0	0	0	0	0
25	Forest-Farm	550.26	0.77	425.50	0.72	306	613	460	536
26	Forest-Farm	654.36	0.79	519.03	0.72	374	747	561	654
27	Forest-Farm	895.83	0.86	766.13	0.72	552	1,103	827	965
28	Forest-Farm	831.03	0.86	718.63	0.72	517	1,035	776	905
29	Forest-Farm	512.52	0.81	415.40	0.72	299	598	449	523
30	Unsuitable for Bear	355.08	0.00	0.00	0	0	0	0	0
Baxter	Forest	241.33	0.92	221.65	0.82	182	364	273	318
State		**31,037.28**	**0.87**	**26,973.00**		**20,866**	**41,732**	**31,299**	**36,515**
Bear Habitat by Region									
Forest		15,028.14	0.96	14,452.29	0.82	11,851	23,702	17,776	20,739
Forest-Farm		15,280.42	0.82	12,520.71	0.72	9,015	18,030	13,522	15,776
Unsuitable for Bear		728.73	0	0.00	0	0	0	0	0

Carrying capacity calculations assume that optimal bear habitat in the Northeast could support 1.5 — 2 bears/sq. mile

Table 5. Projected bear habitat suitability - 2016, assuming loss of beechnut production in the Forest Region , and no net loss of habitat.

WMD	Bear Habitat Category	Land Area (sq. mi)	Percent Bear Habitat	Estimated Bear Habitat (sq. mi)	Bear Habitat Suitability index value	Number of Bear Habitat Units	Carrying Capacity (Number of Bears) High	Carrying Capacity (Number of Bears) Low	Mid Point
1	Forest	1,419.62	0.98	1,392.43	0.5	696	1,392	1,044	1,218
2	Forest	1,189.89	0.98	1,171.22	0.5	586	1,171	878	1,025
3	Forest-Farm	966.29	0.85	816.61	0.72	588	1,176	882	1,029
4	Forest	1,962.74	0.98	1,917.38	0.5	959	1,917	1,438	1,678
5	Forest	1,549.07	0.97	1,508.79	0.5	754	1,509	1,132	1,320
6	Forest-Farm	1,416.85	0.76	1,079.13	0.72	777	1,554	1,165	1,360
7	Forest	1,393.26	0.98	1,364.96	0.5	682	1,365	1,024	1,194
8	Forest	2,054.45	0.98	2,003.25	0.5	1,002	2,003	1,502	1,753
9	Forest	978.71	0.97	950.31	0.5	475	950	713	832
10	Forest	897.87	0.94	839.74	0.5	420	840	630	735
11	Forest-Farm	1,700.15	0.90	1,530.35	0.72	1,102	2,204	1,653	1,928
12	Forest-Farm	996.00	0.92	919.02	0.72	662	1,323	993	1,158
13	Forest-Farm	574.91	0.91	521.55	0.72	376	751	563	657
14	Forest	798.15	0.96	766.98	0.5	383	767	575	671
15	Forest-Farm	1,038.34	0.83	862.27	0.72	621	1,242	931	1,086
16	Forest-Farm	826.06	0.79	653.05	0.72	470	940	705	823
17	Forest-Farm	1,430.45	0.80	1,143.79	0.72	824	1,647	1,235	1,441
18	Forest	1,367.23	0.89	1,218.90	0.5	609	1,219	914	1,067
19	Forest	1,175.83	0.93	1,096.67	0.5	548	1,097	823	960
20	Forest-Farm	646.25	0.75	484.40	0.72	349	698	523	610
21	Forest-Farm	629.39	0.69	437.23	0.72	315	630	472	551
22	Forest-Farm	576.26	0.72	413.33	0.72	298	595	446	521
23	Forest-Farm	1,035.45	0.79	815.29	0.72	587	1,174	881	1,027
24	Unsuitable for Bear	373.65	0.00	0.00	0	0	0	0	0
25	Forest-Farm	550.26	0.77	425.50	0.72	306	613	460	536
26	Forest-Farm	654.36	0.79	519.03	0.72	374	747	561	654
27	Forest-Farm	895.83	0.86	766.13	0.72	552	1,103	827	965
28	Forest-Farm	831.03	0.86	718.63	0.72	517	1,035	776	905
29	Forest-Farm	512.52	0.81	415.40	0.72	299	598	449	523
30	Unsuitable for Bear	355.08	0.00	0.00	0	0	0	0	0
Baxter	Forest	241.33	0.92	221.65	0.5	111	222	166	194
State		**31,037.28**	**0.87**	**26,973.00**		**16,241.06**	**32,482.11**	**24,361.58**	**28,421.85**
Bear Habitat by Region									
Northern Forest		15,028.14	0.96	14,452.29	0.5	7,226	14,452	10,839	12,646
Mixed Forest-Farm		15,280.42	0.82	12,520.71	0.72	9,015	18,030	13,522	15,776
Unsuitable for Bear		728.73	0	0.00	0	0	0	0	0

Carrying capacity calculations assume that optimal bear habitat in the Northeast could support 1.5 — 2 bears/sq. mile The value of Habitat Suitability Variable V11 (nuts produced by trees) was set to 0, for the Forest region, and then the HSI was calculated to simulate total loss of beechnut produciton in the retion. Acorn production is very low in this portion of bear range, and has limited influence on bear food abundance.

the absence of beech mast, the Forest region's adult female population could not sustain annual mortality as light as 2% without declining (McLaughlin 1998).

In most of the Forest-Farm WMD's, bear habitat is expected to change little in overall quality. Residential development will reduce the amount of bear habitat and may result in more conflicts between bears and humans living in the region. To limit bear-human conflicts, bear densities may have to be limited well below the physical capacity of the habitat. Animal damage control efforts will probably become a larger component of future bear management in this region.

The Unsuitable for Bear Region will likely remain unusable as bear habitat in the near future. Human densities in this region will probably rise, and forests will become increasingly fragmented.

The composition of bear habitat, and the manner in which both man's activities and natural forces may affect Maine's landscape, differ across the State. Therefore, greater flexibility in the bear management system will be needed to accommodate regional perspectives and management objectives. The potential catastrophic loss of beech trees due to disease is the only factor that may severely limit bear numbers and harvests in the Forest Region. However, the likelihood of this occurrence is impossible to predict. In the Forest-Farm Region, human attitudes are expected to become increasingly important in limiting bear numbers, primarily the public's tolerance of bear damage and nuisance, rather than by restrictions based upon habitat conditions.

POPULATION ASSESSMENT

Past Populations

Bears were distributed statewide at the time of European settlement (Spencer 1955), and they have been abundant in Maine throughout modern history. Deforestation and persecution of bears to reduce conflicts with agriculture caused their extirpation from much of southern and coastal Maine by 1900. However, they remained common throughout the northern half of the State, outside of the region influenced by farming. Bear range expanded southward as forests regrew following the collapse of agriculture early in the century (Spencer 1955, McLaughlin 1986). By 1985, about 86% of Maine was occupied by bear (Figure 6) (McLaughlin 1986).

Bears are secretive animals that occur in low densities in thick forests, and are difficult to count. In the 1950s, Spencer (1955) estimated the statewide bear population at 5,000-7,000 and increasing, based upon the incidence of tracks, scat and feeding sign along transects traveled on foot or by canoe, and on the age composition of annual harvests (Table 6). In 1975, Hugie relied primarily on harvest statistics to estimate the population at 7,000-10,000 bears statewide. He revised the population estimate to 6,000-9,000 bears in 1979, using both harvest and movement data from radiocollared bears (Hugie 1980). It was later determined that both the 1975 and 1980 population assessments severely underestimated the number of bears in Maine. Neither of these assessments included the trend in population size.

In 1984, bear density estimates from telemetry studies were extrapolated to the 1975 estimate of occupied bear range (22,775 mi^2) to produce a statewide estimate of 18,000 bears (Matula and McLaughlin 1984). The dramatic increase in estimated bear densities, and thus the statewide population estimate, resulted from the realization that female bears were not territorial, as was assumed in earlier population assessments. Instead of excluding other bears from their ranges (territoriality), the movements of radio-collared females indicated that their ranges overlapped considerably. Consequently, considerably greater densities of bears were supported by Maine's forestlands.

During the 1985 bear assessment, updated density estimates from telemetry study sites were extrapolated to a statewide habitat base developed from the 1980 Maine Forest Resurvey (25,850 mi^2) to estimate the spring 1985 population at 21,000 bears and increasing (McLaughlin 1986). Although bear numbers probably increased from 1950 to 1985, the rising population estimates over time period are not direct measures of the growth in bear numbers during the period. Recent knowledge of bear behavior and movements (including their lack of territoriality), and more sophisticated approaches to population monitoring, suggest that early methods to count bears produced conservatively biased estimates.

Population modeling using the vital rates (rates of reproduction, recruitment and mortality) of radiocollared bears on MDIFW study sites indicated that female bear densities began to decline in the late 1980s. Statewide population estimates dropped from 21,000 to 18,490 bears from 1985 to 1990 (McLaughlin et al. 1991). This decline was attributed to

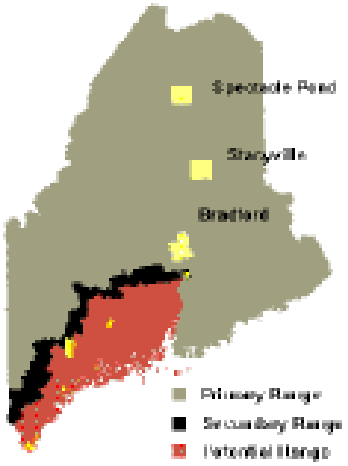


Figure 6. Bear range in Maine, with locations of MDIFW bear study areas

Table 6. Estimates of Maine's black bear population, 1950-1999.

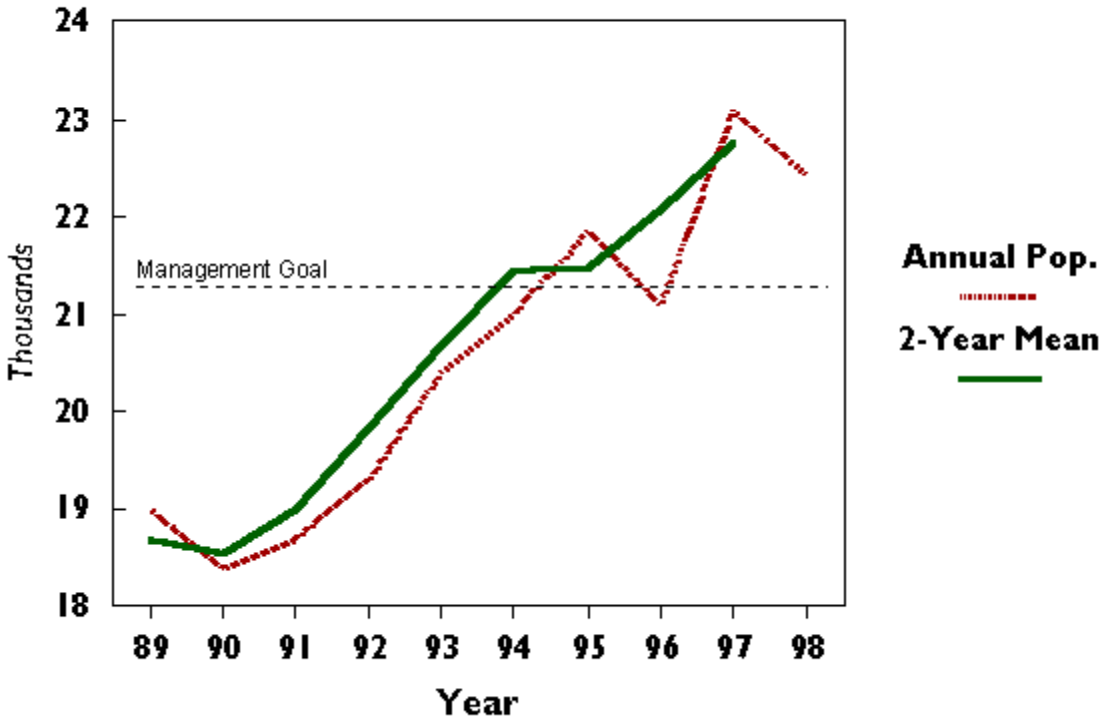
Date	Population Estimate	Trend	Method
1950-1955	5,000-7,000	Increasing	Transects-sign
1975	7,000-10,000	No Estimate	Harvest Statistics
1979	6,000-9,000	No Estimate	Harvest and Telemetry
1984	18,000	Increasing	Extrapolation of Telemetry-based density estimates to area in bear habitat
1985	21,000	Increasing	"
1990	18,490	Decreasing	"
1996	21,000	Increasing	"
1999	23,000	Increasing	"

unsustainable mortality rates due to excessive hunting harvests (Table 6; McLaughlin 1998). Hunting has been the primary mortality agent for subadult and adult bears, with few bears killed on roads or to control damage or nuisance problems (Table 1; McLaughlin 1998).

Current Populations

The bear range has remained relatively static, with perhaps a minor expansion in distribution in southwestern Maine. Survival of radiocollared bears has increased since the last hunting restrictions were implemented in 1990, and modeling indicates that the population is growing (Figure 7). Fluctuating cub production in the Forest Region generates large annual variance in total population size, and confounds efforts to assess population trends. Consequently, we have based management decisions since 1990 on running 2-year mean population sizes, which reduce the variance in population trajectories (Figure 7). By 1996, population estimates had risen to the management objective of 21,000 bears (McLaughlin 1996). The spring 1999 population approximates 23,000 bears (Figure 7).

Figure 7. Maine Bear Population Trend 1989-1998



Population Projections

Under present harvest regulations and current levels of hunting effort, productivity, and habitat conditions, Maine's bear population is expected to grow at the rate of about 2-3% annually for the next 10 years. This projection assumes no net loss in the abundance of mature, nut-producing beech trees in northern Maine, and no significant loss or conversion of forested habitat in southern Maine during the upcoming decade. Both of these assumptions are in line with current trends. The projection also assumes that conditions on 2 small study areas (144 mi^2), located in WMD 5 and 17-18, are representative of the remainder of bear range in Maine. This assumption may not be valid, as habitat, access, and hunting effort likely differ significantly across the State (McLaughlin 1998).

Limiting Factors

Habitat conditions, human attitudes, and hunting-related mortality are expected to limit Maine's bear population in the foreseeable future. Habitat conditions limit a bear population by influencing both reproduction and survival. Given suitable habitat, bear populations exhibit sufficient reproduction to offset mortalities; when reproduction exceeds mortalities, the population has a positive growth rate. The productivity of bears appears to be influenced primarily by food abundance. Maine's female bear population's growth rate, in the absence of hunting, would result in the doubling of the population in 5 years (McLaughlin 1998). Human attitudes toward bears are reflected in management actions and ultimately, in the density of bears on the landscape. Given adequate habitat and public tolerance for bears, hunting harvests are effective in controlling the population's size and limiting the level of conflicts between bears and humans. Other mortality factors, such as those associated with collisions with vehicles, animal damage control, illegal killing, and disease, are inconsequential to the bear population's status at this time.

Because the bear population's viability depends on the status of the adult female cohort, management focuses on this population segment. Male bears travel widely and often mate with several females in a breeding season. Their survival is generally lower than females', but short-term population growth and viability does not appear to be strongly associated with male survival rates. Instead, population growth is closely associated with the proportion of breeding females producing litters, and with survival of adult females (McLaughlin 1998). Regional variation in the composition and quality of Maine's bear habitat translates into differences in the productivity of bears throughout the State.

Forest Region

In the Forest Region, beechnut abundance appears to control the productivity of bears. A substantial change in the abundance and distribution of mature, nut bearing beech trees would have a significant impact on bear productivity, and therefore on the population's ability to withstand harvests. Computer modeling of simulated bear populations (McLaughlin 1998) suggests that, under present nutritional conditions, adult female bears in the Forest Region can withstand annual harvest rates of 10% without declining. The modeling effort incorporated data on the densities and vital rates of radio-collared female bears studied over a 15-year period (McLaughlin 1998).

The productivity of bears in the Forest WMDs would probably decline severely given a widespread loss of beechnut mast. Such a region-wide loss of beechnuts would most likely be caused by large scale beech tree mortality from disease or excessive timber harvest (see Habitat). Because beech does not produce regular nut crops until 40 years of age (Fowells 1965), a sudden, catastrophic loss of beech trees would probably translate into a long-term reduction in the nutritional plane of bears living in the region, and a drastic reduction in cub production (McLaughlin 1998). Under such a scenario, the age structure of the population would become markedly older, with proportionately fewer cubs and subadult bears. Consequently, hunting harvests would have to be severely curtailed or even eliminated to sustain current population densities in northern Maine (McLaughlin 1998).

Forest-farm Region

No major threats to the population are known in the Forest-Farm Region (most of central, southern, and northeastern Maine). Computer simulation modeling indicates that the bear population in this region is able to sustain 15% adult female mortality (McLaughlin 1998). Cub production in this region may also decline if beech mast was lost, but less dramatically than in the Forest, as bears utilize a wider range of fall foods in central and southern Maine. Programs to educate private landowners on ways to maintain and enhance a variety of fall food-producing vegetation on their lands (Wiley 1999) may help to mitigate the affect of beech bark disease on bears in this region.

Although residential development is occurring in Maine, housing densities are likely to remain sparse enough to support bears over most of presently occupied bear range. Therefore, no net loss in habitat is expected through 2016. Maine's habitat is able to support greater bear densities than people would tolerate. As development continues in the Forest-Farm Region, the incidence of bear-vehicle collisions, nuisance complaints and other bear-man conflicts will rise. In this region, the major factor limiting future bear densities will be human attitudes. Elsewhere, programs to increase people's knowledge and tolerance of bears have been responsible for coexistence of bears and people on relatively urbanized landscapes (e.g., Pennsylvania, New Jersey, Arizona, Massachusetts).

USE AND DEMAND ASSESSMENT

Past Use and Demand

Over the past century, the black bear was regarded as both a species that caused conflicts with other land uses, primarily agriculture (i.e., crop and livestock depredation, nuisance in campgrounds/backyards) and as a desirable species of high esthetic value (i.e., big game trophy, symbol of the wild). During the early 1900s, bears were bountied as pests and occasionally sold to nonresident sportsman as trophies from the north woods (Spencer 1955). As Maine's economy became less agricultural, the nature of bear-man conflicts changed and bounties were removed from bears in 1957 (Table 2). Coincidentally, interest in hunting bears as big game fueled an outfitter industry that capitalized on the practice of hunting bears with bait, and to a lesser extent with hounds (Hugie 1975). This commercialization of bear hunting catered to nonresident hunters, primarily those traveling from other Eastern states with few bears and limited opportunities to hunt them. Bear hunting became popular in Maine in the early 1970s, and demand continued to rise through the 1980s. The popularity of hunting over bait was largely responsible for a rapid and sustained increase in bear harvests during the 1970s, and again in the late 1980s (Table 2, Figure 3). Harvests rose from a level just below 1,000 bears to 1,630 bears in 1979, when the Department shortened the bear season drastically by removing the spring hunting period. Harvests were curtailed to about 1,000 bears for a few years, but rapidly rose to 2,690 bears during the late 1980s. The Department placed additional restrictions on season length in 1990 to curtail harvests.

Historically, the number of individuals participating in bear hunting appears to have been a small fraction of licensed big game hunters. From 1971 to 1983, the Game Kill Questionnaire was used to survey licensed hunters and determine effort expended on many wildlife species. This survey produced estimates of 21,000 - 34,000 bear hunters most years of the period (Table 2). Over 200,000 hunters purchased licenses each year of the survey period, and the survey's estimates of bear hunters included those that pursued bears incidentally while hunting other species, primarily deer and upland birds.

A survey of bear hunters in 1988 (Reiling et al. 1991) estimated that 20,676 hunters (14,321 residents; 6,355 nonresidents) pursued bears that year. Seventy percent of respondents indicated that they hunted bears in September, but only 23% hunted bears in November. Most nonresident respondents (62%) hired a Registered Maine Guide to assist them during their hunt; only 4% of resident bear hunters used the services of a guide. Seventeen percent of the 1988 survey respondents reported that they were successful in killing a bear, including 26% of nonresidents and 13% of resident hunters.

The 1988 survey of bear hunters estimated that bear hunting generated $6.4 million, including $3.4 million of new money for the State's economy provided by nonresident hunters (Reiling et al. 1991). No other measures of the economic benefit of bear hunting have been published.

Nonconsumptive demand for bears is difficult to measure. Maine's dense forests provide few opportunities to view bears. However, bears remain a popular species with campers, fishermen, and other outdoor enthusiasts that are able to catch a glimpse of them.

Current Use and Demand

Since 1990, bear hunting permit sales have provided a reliable measure of bear hunting effort for the first 2 months of Maine's 3-month bear season. This hunting period represents most of the hunting effort directed specifically at bears each year. Although hunters take bears in conjunction with deer hunting, few hunting trips are taken specifically to hunt bears in November. Just over 12,000 permits were sold in 1990, and hunter numbers have remained relatively stable since then, with 10,000-11,000 permits sold each year (Table 2). This level of participation represents approximately 5-6% of big game hunting license sales during the period (MDIFW file data). Over half of the permits sold each year have been purchased by Maine residents (Table 7). Not all permit buyers actually hunt bear. Hunting participation rates are lower for resident bear permit-buyers (74-79%) than for nonresidents (93-96%) (Table 7). However, residents hunted more days each season than nonresidents, regardless of hunting method. Consequently, residents expended 66% of the bear hunting effort by permit holders from 1991-1994 (Table 8). Hunting effort could not be evaluated on a geographic basis, as many hunters responding to the survey were unable to accurately recall which townships they had hunted in.

Bear harvests were effectively reduced with the harvest controls implemented in 1990, but they soon began to increase, and are returning to the levels of the late 1980s (Table 3, Figure 3). In addition to hunting effort, harvests are also influenced by annual food abundance and distribution, weather during the hunting season, and the size of the bear population. Much of the harvest increase can be attributed to increased hunting pressure prior to the firearms deer season (Figure 3). The trend of increasing harvest over a period of stable hunting effort is a strong indicator that the bear population is increasing. Success rates of hunters using various methods were explored in a random survey of permit-buyers following the 1991-1994 seasons. Nonresident hunters were 2-3 times more successful than residents for all methods (Table 9). This disparity in success, despite substantially lower number of days hunting by nonresidents, results from most nonresidents employing Registered Maine Guides to assist them.

Most of the annual bear harvest is contributed by hunters using bait. Houndsmen's harvests have fluctuated markedly, and constitute a rather small proportion (12-16%) of annual harvests. Maine still allows trapping of bears, but few bears are trapped each year, and a consistent 2% of the harvest is reported by trappers. The number of bears taken by hunters that are still-hunting or stalking bears fluctuates, but relatively few bears are harvested in this manner (Figure 3). Most of these hunters pursue bears near seasonal food sources in September and October.

During November, the bear harvest is strongly correlated with the abundance of beechnut mast in northern Maine; when beechnuts are scarce, most bears enter dens early, often before the November firearms season opens. Consequently, they are unavailable for harvest, and few are killed. Conversely, when beechnuts are abundant, bear remain active and late-fall harvests increase. A pattern of alternating years of high and low harvests during November has been recorded for over a decade (Figure 3).

Although bear harvests during deer season fluctuated with beechnut crops in the Forest WMDs, the relative contribution of this late-fall harvest to the overall harvest waned as early season harvests over bait climbed through the 1990s (Figure 3). In recent years, late-fall harvests have accounted for about 7-25% of the season total (Table 3, Figure 3).

Nonconsumptive use of bears is difficult to quantify. Statistics on the public's interest in viewing bears in particular are unavailable, but 54% of people traveling to view wildlife in Maine during 1996 were interested in watching large land mammals, including deer, bear and moose (USFWS and USBC 1998).

Use and Demand Projections

Demand for bear hunting opportunity is expected to remain at current levels over the next decade. Although overall participation in hunting in Maine is declining, bear permit sales appear stable. Although demand for bear hunting opportunity continues, the consumptive use of Maine's bear resource may be affected by changing views of hunting by the nonhunting public. The ethics of hunting bears, and the methods used to hunt bears, are being debated elsewhere in North America. Voters in Oregon, Washington, Colorado and Massachusetts have outlawed the use of bait and/or hounds to hunt bears in recent years. Ontario's Minister of Natural Resources closed the 1999 spring bear hunting season in the Province, in response to concern over orphaning of young cubs. Maine is one of a dwindling number of states (currently 6) that still permit the use of bait and hounds to hunt bear, and is the only state that permits trapping for bear. If these 3 harvest methods are outlawed, the Department's ability to control bear numbers through regulated hunting seasons will be compromised. A significant expansion of stillhunting or stalking opportunities, including longer seasons and multiple-bear bag limits, would probably be the most likely approach to increase harvest levels and attempt to manage the population.

SUMMARY AND CONCLUSIONS

Black bears are widely distributed in Maine, occurring in all but the extreme southcentral and southwestern portions of the State. Bears use large areas, and are usually associated with expansive tracts of forestland. They are omnivores, and although most of their diet is vegetation, bears will eat a variety of animal matter. Their movements and activities revolve around the distribution and abundance of foods. Bears restrict their movements when food is abundant, but often travel up to 50 miles in summer or fall to take advantage of berry or nut crops. Studies elsewhere have shown that black bears can be important predators on newborn deer and moose, but their impact on Maine's deer and moose populations is not known.

Although bears are long-lived, they are slow to reproduce, and have a low reproductive potential. Females do not produce cubs until 4-6 years of age in the State, and normally produce litters of 1-4 cubs at 2-year intervals. Cub production is strongly influenced by beechnut abundance in the expansive forests of northern Maine. Alternate-year beechnut crop failures have synchronized the reproductive cycles of most females in the population. Consequently, cub production in the region occurs as strong, alternate-year pulses. Fall food abundance influences the timing of den entry, which varies from mid-October when food is scarce to late November in years of abundant nut crops. Bears spend up to 6 months of the year in dens in Maine.

Cub and yearling bears die primarily from natural causes, including starvation and disease, and are occasionally killed by larger bears. The deaths of most subadults and adults are hunting related, and few die from collisions with vehicles. Disease does not appear to play a significant role in the regulation of bear populations. Instead, bears seem to be regulated by food abundance, which influences reproductive success and survival.

Bear management in Maine reflects the species' rise in status from a pest to big game species. Concurrently, they have received increased protection and monitoring over the last hundred years. Bear were hunted year round for much of the first half of the century, and were bountied until 1957. Bear seasons were shortened to a 6-month period in the 1960s. Since 1982, a 3-month fall-only season has been in place, and additional restrictions on the periods that individual harvest methods were permitted within the fall season were enacted in 1990. These restrictions were designed to maintain bear populations in the face of escalating interest in bear hunting and rising harvests. Since 1990, hunting over bait has been allowed for 4 weeks, and houndsmen have been restricted to a 6-7 week hunting period. Trapping was expanded from a 1-

month to a 2-month period during the 1990s, and stillhunting and stalking is now permitted for the entire 13-14 week season. Hunters are restricted to taking one bear per year, regardless of method. A bear hunting permit is required of hunters that pursue bears during the first 2 months of the season.

The first bear management goal in 1975 was to maintain bear abundance, distribution and use at pre-1974 levels. Harvests were to be maintained at 800-1,000 bears per year. This goal and objective remained unchanged in 1980. In 1985, the Department's bear management goal was changed — to maintain the distribution and abundance of bears at 1985 levels. The associated population objective was to maintain the population at about 21,000 bears, with a harvest objective set at 1,500-2,500 bears per year. This goal and objectives have guided bear management through 1999. Since 1990, an interim harvest objective, of maintaining the harvest at no greater than 2,300 was used to ensure positive population growth.

The Department began monitoring bear harvests in 1969, and began the bear study in 1975. Harvests escalated in the 1970s, exceeding the 1,000 bear objective and resulting in the closure of spring bear hunting season in 1980-1981. Harvests were initially curtailed to less than 1,500 bears, but soon rose rapidly in the late 1980s, and exceeded the 1985 management objective (1,500-2,500) in 1988 and 1989. Additional restrictions on hunting opportunity were implemented in 1990. Harvests were curtailed once again, but soon began to rise. Since 1990 harvests have exceeded the management objective twice (1995 and 1998), despite stable hunting effort during the period.

Land clearing for agriculture reduced bear habitat to the northern half of Maine by the turn of the century. Since then, bear range has expanded with the regrowth of forests on previously-farmed areas in much of eastern, central, and western portions of the State. The amount of bear habitat has remained relatively static over the past 20 years, and is currently estimated at 26,973 mi^2. Maine has sufficient habitat to support about 36,000 bears.

The bear population has been estimated several times over the past 50 years. Improved monitoring techniques and knowledge of bear ecology resulted in rising population estimates between 1950 and 1985. Estimates of the statewide bear population rose from 5,000-7,000 bears in 1950 to 21,000 bears in 1985, then declined to 18,500 in 1990. With restricted hunting seasons during the 1990s, the population has been growing, and numbered about 23,000 bears by spring 1999, slightly over the management objective of 21,000 bears. Given no change in habitat conditions, harvest regulations, and hunter participation, the population should continue growing at about 2-3% annually for the next few years.

The future productivity of bears in northern Maine is expected to track the availability of mature, nut-producing beech trees. It is uncertain whether a catastrophic loss of beech trees will occur in the region; many stands are heavily infected with beech bark disease, and mature beech trees continue to be removed through timber harvests. If a region-wide loss of beech does occur, productivity of the area's bear population, and its capacity to sustain hunting harvests, will probably decline precipitously. In western, central and eastern Maine, bear productivity will be less affected by a loss of beechnut crops, as they have alternate fall foods. This region is likely to continue to undergo residential development, and as human populations rise, bear-human conflicts will increase. Bears in this region will likely be limited by the public's tolerance of them.

Since the early 1970s, demand for bear hunting opportunity by nonresidents has fueled a commercial guiding industry that concentrates on providing hunts over bait and behind hounds. Since 1990, sales of bear hunting permits have allowed the Department to monitor hunting pressure; between 10,000-11,000 hunters purchase permits annually, and 8,000-9,000 permit buyers actually hunt bears. Most permit buyers are residents of Maine, but more nonresidents are successful in taking bears. About 60% of recent bear harvests were taken by nonresidents. Harvests averaged 2,408 bears during 1990-1998, and increased despite a steady level of hunting effort. Maine continues to offer considerably more hunting opportunity for bears than other eastern States, with longer seasons and a greater variety of legal hunting methods. The bear season currently extends from late August through November. Hunters may take 1 bear per year; bait, hounds, still hunting, stalking, and trapping are legal methods of take. About 60% of recent harvests have been taken over bait, 15% over hounds, and 2% by trapping. The remainder (23%) are taken by hunters that still hunt or stalk bears, often taking them incidentally while hunting other species. The number of bears taken during the November deer season fluctuates about 3-fold, from about 150-450 bears, depending upon the timing of den entry by northern Maine bears. This late fall harvest is less predictable than earlier harvests by bait, hounds or trapping, but it has contributed less to the overall harvest in recent years, as early season harvests increase in size.

Demand for hunting opportunity is expected to continue at current levels into the near future. Hunting has been used as the primary tool to regulate bear numbers, but in the future, public debate about the ethics of hunting bears, primarily with bait and hounds, may complicate bear management and force changes in bear seasons, and policy regarding nuisance bears. If hunting over bait is outlawed in the future and current habitat conditions and productivity continue, substantial liberalization of hunting seasons and/or bag limits will be required to maintain bear harvests large enough to control population growth. The uncertainty of widespread loss of beech trees in northern Maine further complicates the projection of bear supply and demand. Given the potential for less flexibility in harvest methods and a potential change in bear productivity, future bear management systems need to improve monitoring of the population and habitat, and incorporate harvest controls at a regional scale.

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Table I-1. Bear Habitat in Maine (1975 and 1980 Assessments).

Mngmn't Unit	Bear Habitat					% of Unit in Bear Habitat	Bear Habitat (Sq. Miles)	% Bear Habitat Forested	% of Total Bear Habitat in Maine
	Area[1]	Suitable[2] Woodland	Farmlands[3]	Useable[4] Wetlands	Total[1]				
1	1,553,423	1,044,632	40,625	11,485	1,096,742	70.6	1,719	95.2	7.5
2	5,970,378	5,447,060	5,502	68,003	5,520,565	92.5	8,626	98.7	37.9
3	2,544,753	2,291,130	trace	25,589	2,316,719	91.0	3,620	98.9	15.9
4	3,636,155	2,720,273	19,715	40,523	2,780,411	77.0	4,344	97.8	19.1
5	1,884,023	1,616,315	3,298	42,520	1,662,133	88.2	2,597	97.2	11.4
6	1,670,291	1,068,204	8,877	10,802	1,087,883	65.1	1,700	98.2	7.5
7	1,365,573	46,080	1,439	496	48,015	3.5	75	96.0	0.3
8	1,781,715	61,279	1,835	619	63,738	3.6	100	96.1	0.4
State	20,406,311	14,294,873	81,291	200,038	14,576,206	71.4	22,775	98.1	100.0

[1] All area given in acres unless otherwise noted.

[2] Woodland includes wooded swamp

[3] Farmlands include 10 percent of all types of farmland, except that occurring in Units 7 and 8.

[4] Useable wetland includes 50 percent of: seasonally flooded basins, fresh meadow, shrub swamp, and bog, except for those that occur in Units 7 and 8.

Appendix II

Assumptions and Variables used to Assess Bear Habitat Suitability in the 1999 Black Bear Assessment

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MaryEllen R. Wickett

December, 1999

Procedure Used To Assess Bear Habitat in Maine — 1999

This appendix summarizes the data sets, procedures, and assumptions used to generate the Habitat Assessment portion of the 1999 Bear Assessment and Strategic Plan. Data summaries are archived by the Wildlife Habitat Group at the Bangor Office and by the Wildlife Planner at the Augusta Office.

Bear habitat was quantified in the following order:

1. Determine the amount of potential bear habitat in the state.
2. Determine the suitability (quality) of bear habitat.
3. Determine carrying capacity.

Data Sources

The vegetation and land cover map used in the Gap Analysis of Maine (ME-GAP; Hepinstall et al. 1999, Krohn et al. 1998) - modified to incorporate all National Wetland Inventory polygons, 1995 Forest Inventory of Maine (USFS 1997), 1997 Census of Agriculture (USBC 1999), miles of public roads by town (Maine Dep. of Transportation 1997 data), and the 1999 Deer and Moose assessments (Lavigne 1999, Morris 1999) provided data for this evaluation of the quantity and quality of bear habitat.

Amount of Bear Habitat

The modified ME-GAP provided data for determining the amount of bear habitat. This information was summarized by Wildlife Management District. Habitat-related differences in the distribution and abundance of fall foods influence the reproductive schedules of female bears. In northern Maine, bear productivity is limited, due to dependence on a solitary food source that fluctuates in abundance from year to year, i.e., beechnuts. In much of the remainder of the State, bears use a variety of fall foods (partly due to past and present agricultural practices), and populations are more productive. Parts of south-coastal Maine and offshore islands have fragmented forestland and dense development, and are not considered to be bear habitat. Therefore, the 30 WMDs in the State were grouped into 3 categories, according to how much agricultural land they contained, and knowledge of forest fragmentation and human presence.

WMDs with <6% of their areas in agricultural lands (Table II-1) were assigned to the Forest Region (Figure 5 of Bear Assessment). Baxter Park was also assigned to this region, as 1.5% of its area is considered agricultural lands. The remaining WMDs (except WMD 24 and 30) contained 6.3% - 25.4% agricultural lands (Table II-1), and these were assigned to the Forest-Farm Region (Figure 5 of Bear Assessment). WMD 24 and 30 were excluded from bear range due to development and fragmented forestland.

The amount of land in all categories of forestlands and 5 categories of forested/scrub-shrub wetlands (Table II -1) within each WMD were considered potential bear habitat. The Bear Habitat Suitability Index was applied to this estimate of potential bear habitat.

Suitability of Bear Habitat

The Bear Habitat Suitability Index (McLaughlin et al. 1988 - Appendix III) developed for the 1985 bear assessment was updated, and the modified ME-GAP data, 1995 Forest Resurvey data, 1997 Census of Agriculture, 1997 public road miles, and MDIFW data on deer and moose densities were applied to the model to generate a HSI value for each of the bear habitat regions (Forest and Forest-Farm)(Table II-1).

The published model (McLaughlin et al. 1988 - Appendix III) was modified as follows for the 1999 assessment of bear habitat:

1) Removal of one food variable (V_{12} : garbage);
2) Correction of the equation for V_3 — units had been mislabeled on the suitability index axis;
3) Several variables measured during the 1982 Forest Resurvey were not included in the 1995 Resurvey, and data measures used to determine the suitability indices for several variables were refined:

V[1] -**herbaceous vegetation:** permanent opening and time since harvest were not recorded during the 1995 Forest Resurvey. Modifications took into account whether forest stands were classified as seedling or nonstocked stands, and whether agricultural edge was present in the stand. In addition, calculations which determined the percentage of forestland in each sample plot incorporated ecotype (e.g., forest vs. grasslands) delineation and weighting by area (acres);

V[3] -**colonial insects:** The presence of a cavity was not recorded during the 1995 Forest Resurvey. Modification included using dead-down tree categories and condition/damage levels to indicate the presence of colonial insects;

V[10] -**nuts produced by trees:** We established minimum dbh limits for trees identified as nut producers (see details below);

V[14] -**interspersion of food sources:** Forest stand area was not collected during the 1995 Forest Resurvey. This measure was refined by calculating the area of homogeneous cover type patches delineated from modified ME-GAP;

4) We changed the measure of V[15] -suitable forestland to reflect our knowledge that bears tolerate greater fragmentation of forestland than was assumed in 1985. For the 1999 assessment, suitable forestland was identified as all forest habitat (modified ME-GAP) with public road density <2 km public road/km^2 town area.

Changes in HSI Model Relationships

Table II-1. Percentage of MDIFW Wildlife Management Districts composed of different land cover designations, based upon the modified Maine GAP project.

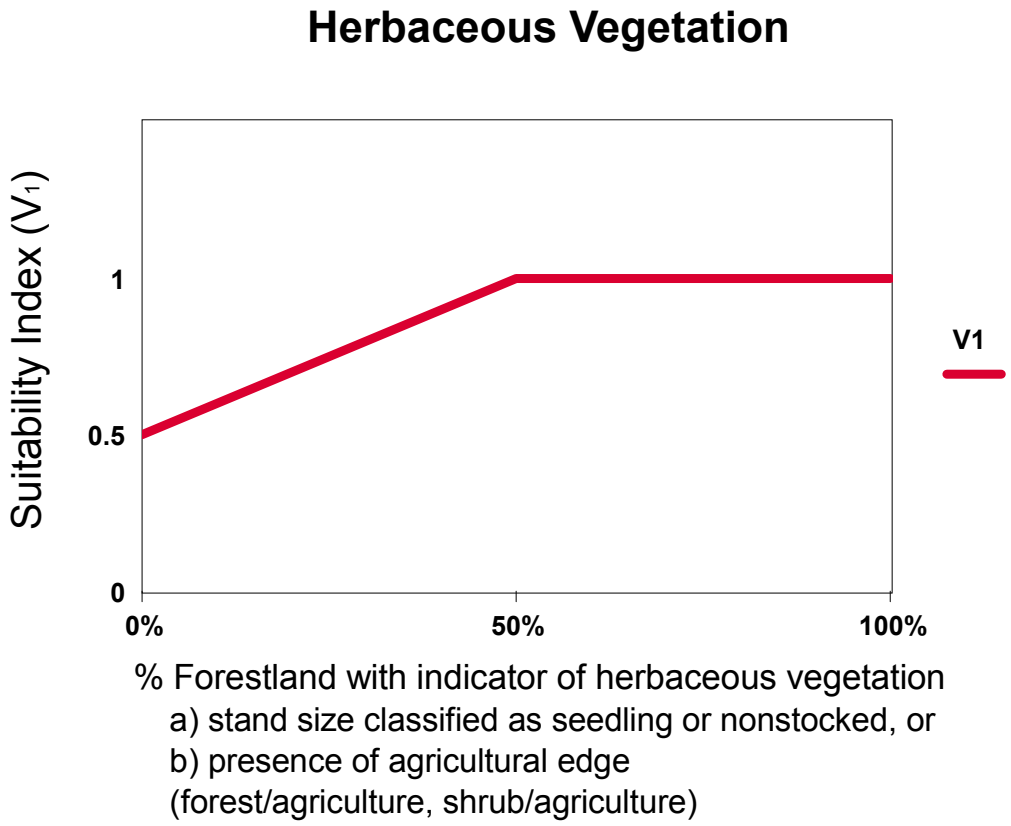
WMD	Agricultural Lands	Forestlands[1]	Forested/ Scrub-shrub Wetlands[2]	Other Wetlands	Developed Lands	Other	Totals	Standard estimate of land area (sq. mi) used in MDIFW species assessments
1	0.12%	91.65%	6.43%	1.73%	0.06%	0.00%	100.00%	1,419.62
2	0.62%	92.84%	5.59%	0.88%	0.07%	0.00%	100.00%	1,189.89
3	12.82%	73.79%	10.72%	1.96%	0.71%	0.00%	100.00%	966.29
4	0.04%	88.27%	9.42%	2.27%	0.00%	0.01%	100.00%	1,962.74
5	0.71%	86.72%	10.68%	1.87%	0.02%	0.00%	100.00%	1,549.07
6	21.12%	63.94%	12.23%	1.40%	1.31%	0.00%	100.00%	1,416.85
7	0.89%	93.54%	4.43%	0.84%	0.30%	0.00%	100.00%	1,393.26
8	0.05%	90.83%	6.67%	2.33%	0.10%	0.01%	100.00%	2,054.45
9	0.25%	90.55%	6.55%	2.51%	0.05%	0.10%	100.00%	978.71
10	2.06%	83.83%	9.70%	3.40%	1.01%	0.00%	100.00%	897.87
11	6.28%	72.32%	17.69%	2.29%	1.42%	0.00%	100.00%	1,700.15
12	6.37%	87.90%	4.37%	0.75%	0.60%	0.02%	100.00%	996.00
13	7.44%	85.16%	5.56%	1.24%	0.60%	0.00%	100.00%	574.91
14	1.86%	89.37%	6.72%	1.54%	0.53%	0.00%	100.00%	798.15
15	14.30%	75.53%	7.51%	1.62%	1.00%	0.03%	100.00%	1,038.34
16	16.85%	71.49%	7.56%	2.18%	1.90%	0.01%	100.00%	826.06
17	15.99%	68.52%	11.44%	2.15%	1.90%	0.00%	100.00%	1,430.45
18	3.01%	73.13%	16.02%	5.53%	2.31%	0.00%	100.00%	1,367.23
19	1.34%	80.29%	12.98%	4.03%	1.36%	0.00%	100.00%	1,175.83
20	20.81%	63.06%	11.90%	2.25%	1.84%	0.14%	100.00%	646.25
21	25.40%	62.04%	7.43%	1.74%	3.20%	0.19%	100.00%	629.39
22	21.08%	65.71%	6.01%	3.36%	3.84%	0.00%	100.00%	576.26
23	16.08%	67.84%	10.89%	2.93%	2.25%	0.00%	100.00%	1,035.45
24	21.72%	49.51%	8.47%	6.90%	13.12%	0.29%	100.00%	373.65
25	14.97%	70.18%	7.15%	4.68%	3.03%	0.00%	100.00%	550.26
26	12.40%	72.71%	6.60%	3.98%	4.30%	0.00%	100.00%	654.36
27	6.32%	79.26%	6.26%	4.27%	3.34%	0.55%	100.00%	985.83
28	7.86%	74.72%	11.76%	4.90%	0.77%	0.00%	100.00%	831.03
29	11.08%	71.29%	9.76%	5.99%	1.87%	0.01%	100.00%	512.52
30	5.23%	36.77%	2.76%	53.29%	1.88%	0.06%	100.00%	355.08
Baxter	0.74%	87.98%	3.87%	1.30%	0.00%	6.12%	100.00%	241.33
Statewide	7.43%	78.95%	9.19%	3.04%	1.31%	0.08%	100.00%	31,037.28

[1]Modified ME-GAP landcover designations in forestlands include clearcut, early regeneration, late regeneration, light partial cut, heavy partial cut, deciduous forest, deciduous/coniferous forest, coniferous/deciduous forest, and coniferous forest.

[2]Modified ME-GAP landcover designations in forested/scrub-shrub wetlands include deciduous forested wetland, coniferous forested wetland, dead-forest wetland, deciduous scrub-shrub wetland, coniferous scrub-shrub wetland, and dead scrub-shrub wetland.

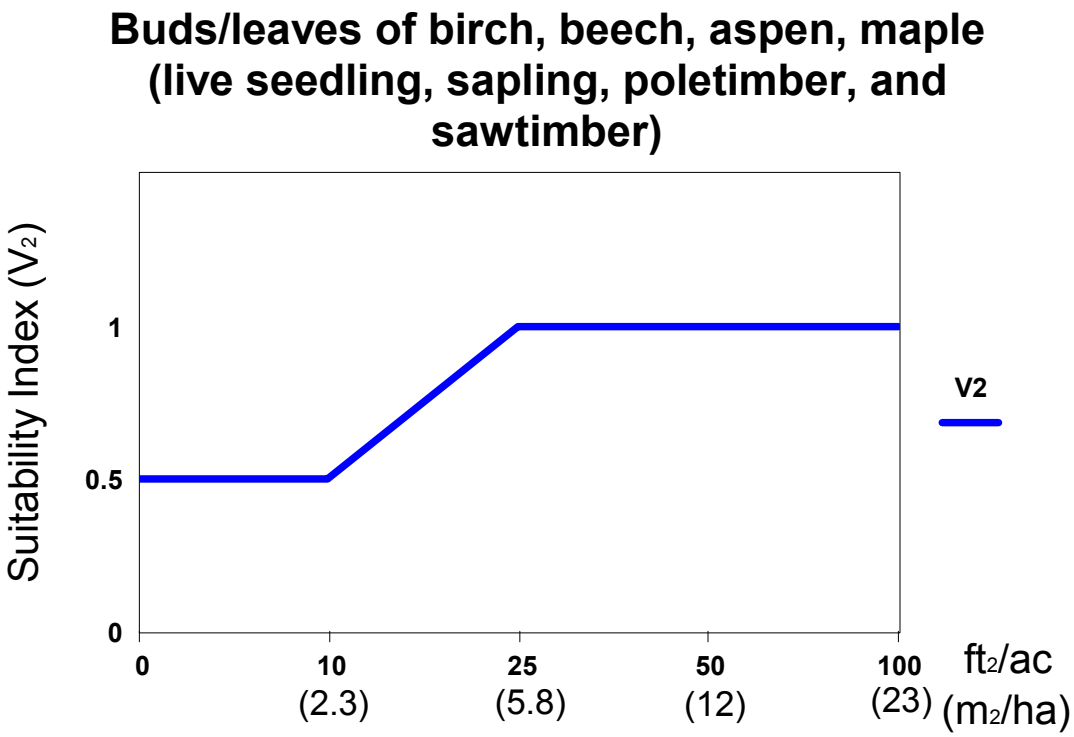
Table II-2. Individual black bear HSI variable values (food SI, cover SI), and overall HSI values assigned to each of 8 MDIFW Wildlife Management Units (WMU) and to the 2 bear habitat zones for the 1999 bear assessment, with comparable HSI values calculated during the 1985 black bear assessment.

Variable	WMU								Bear Zone	
	1	2	3	4	5	6	7	8	Forest	Forest-Farm
V1	0.93	0.67	0.68	1.00	0.73	0.82	1.00	1.00	0.69	1.00
V2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V4	0.88	0.97	1.00	0.78	0.81	0.73	0.70	0.69	1.00	0.86
V5	0.72	0.88	1.00	0.92	0.69	0.82	1.00	1.00	0.91	0.99
V6	0.50	0.50	0.50	0.52	0.85	1.00	0.73	0.52	0.56	0.71
V7	0.62	0.50	0.50	0.71	0.50	0.51	0.92	0.86	0.50	0.83
V8	0.81	0.75	0.76	0.98	0.75	0.76	1.00	1.00	0.76	0.92
V9	1.00	0.75	0.75	0.76	0.75	0.75	0.75	0.75	0.75	0.81
V10	1.00	1.00	1.00	1.00	0.93	0.83	1.00	1.00	1.00	1.00
V11	0.55	0.66	0.66	0.80	0.61	0.53	0.86	0.92	0.66	0.72
V12										
V13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V14	0.77	0.74	0.78	0.80	0.76	0.75	0.84	0.84	0.75	0.79
V15	0.95	1.00	1.00	0.98	1.00	0.97	0.93	0.85	1.00	0.95
V16	0.91	1.00	0.93	0.73	0.96	0.80	0.50	0.44	0.98	0.72
Food Value	0.84	0.81	0.82	0.87	0.80	0.81	0.91	0.90	0.82	0.90
Cover Value	0.91	1.00	0.93	0.73	0.96	0.80	0.50	0.44	0.98	0.72
HSI	0.84	0.70	0.82	0.73	0.80	0.80	0.50	0.44	0.82	0.72
1985 VALUES										
FOOD	0.77	0.70	0.74	0.80	0.77	0.80	0.81	0.79		
COVER	0.93	1.00	0.99	0.88	0.97	0.90	0.71	0.63		
HSI	0.77	0.70	0.74	0.80	0.77	0.80	0.71	0.63		
CHANGE	0.07	0.11	0.08	0.07	0.03	0.01	0.10	0.11		
	-0.02	0.00	-0.06	-0.15	-0.01	-0.10	-0.21	-0.19		
	0.07	0.11	0.08	-0.07	0.03	0.00	-0.21	-0.19		



Cover Type	Variable
Forestland	V_1
All forest type groups, stand sizes, and stocking	

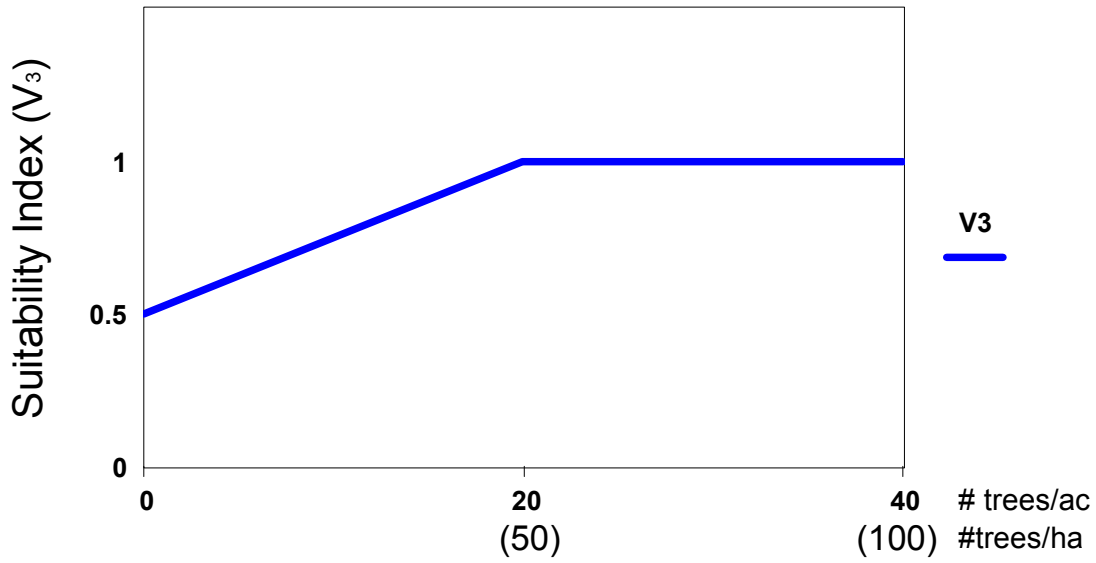
Suitability Index Curves



Cover Type	Variable
Forestland	V_2
All forest type groups, stand sizes, and stocking	

Cover Type	Variable

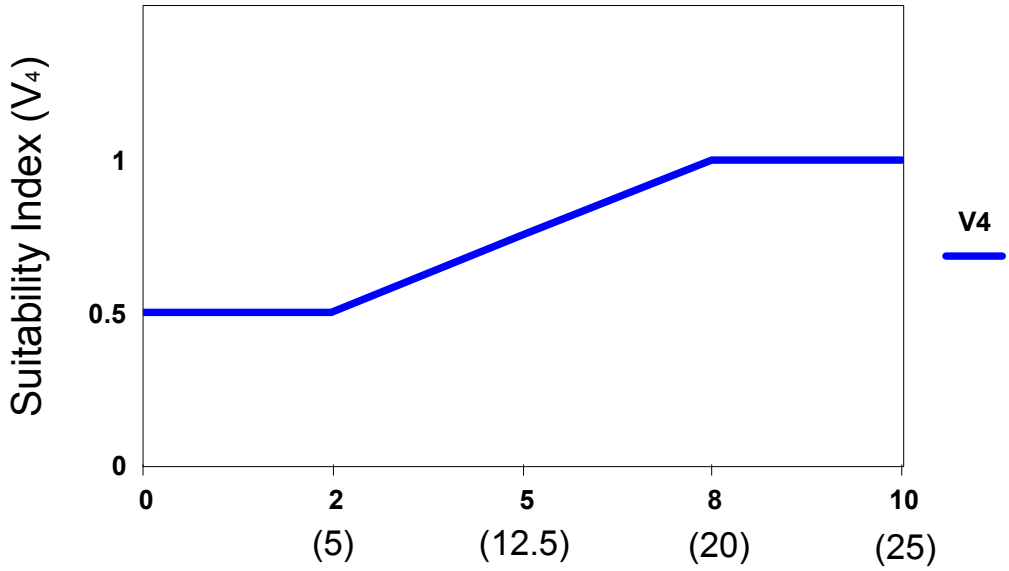
Colonial Insects



Number of snag, dead and dead down trees, and trees indicating general insect damage or specific damage by borers and bark beetles/acre (ha) of forest.

Forestland All forest type groups, stand sizes, and stocking	V_3

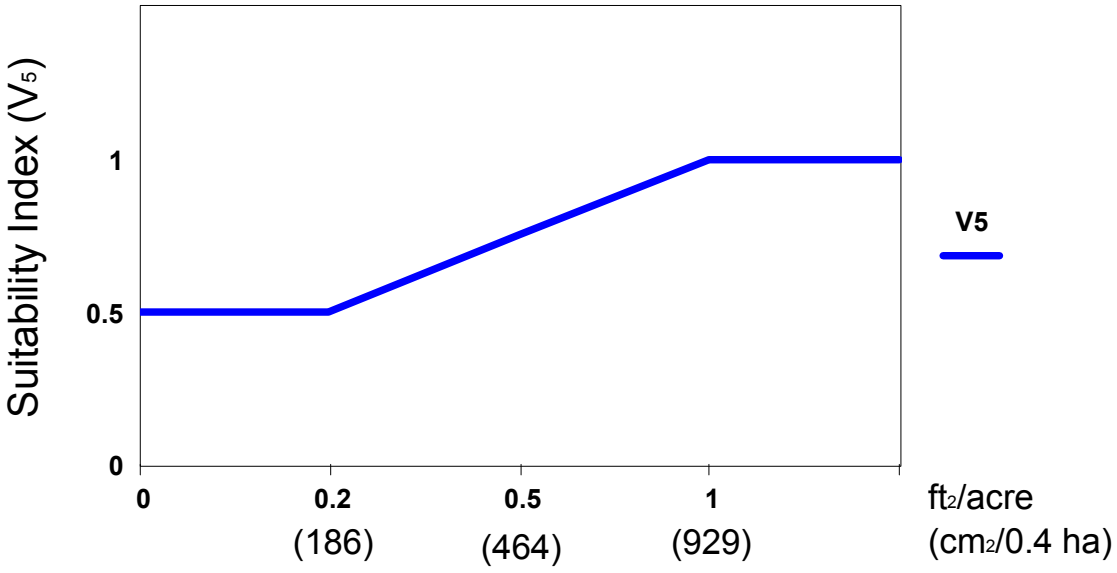
Berries produced by shrubs or vines



Thousands of stem-diversity units/acre (ha) of forest.

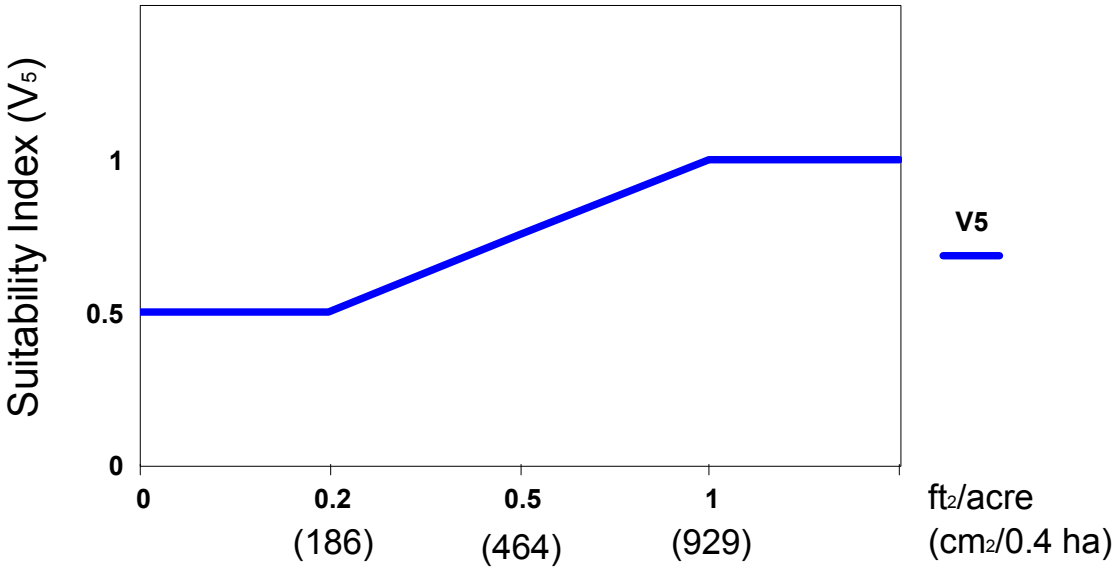
Cover Type	Variable
Forestland	V_4
All forest type groups, stand sizes, and stocking	

Berries produced by trees



Basal area of serviceberry and cherries (pin, black, and choke)/acre (0.4 ha) of forest.

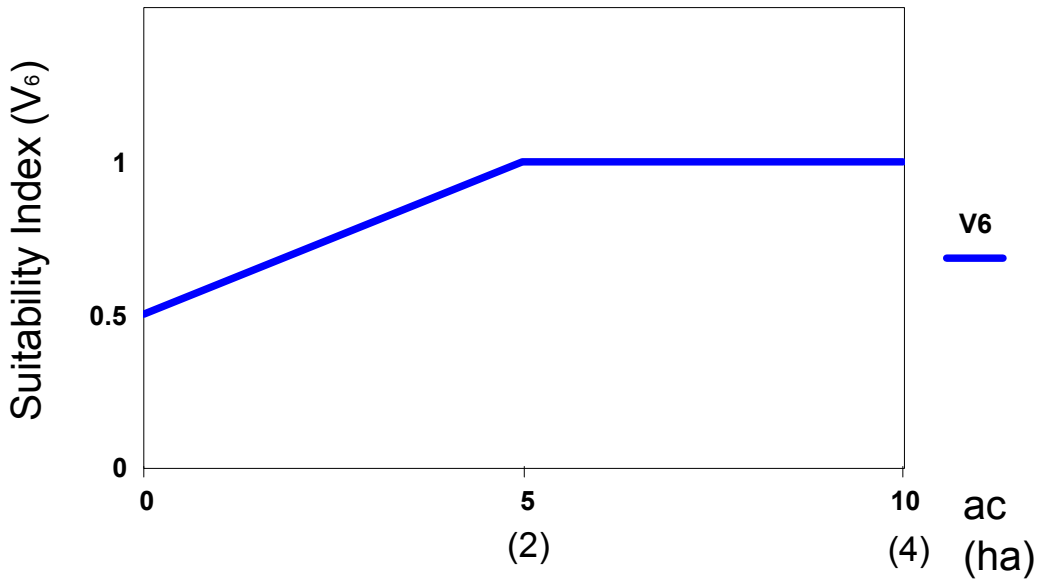
Berries produced by trees



Basal area of serviceberry and cherries (pin, black, and choke)/acre (0.4 ha) of forest.

Cover Type	Variable
Forestland All forest type groups, stand sizes, and stocking	V_5

Cultivated berries

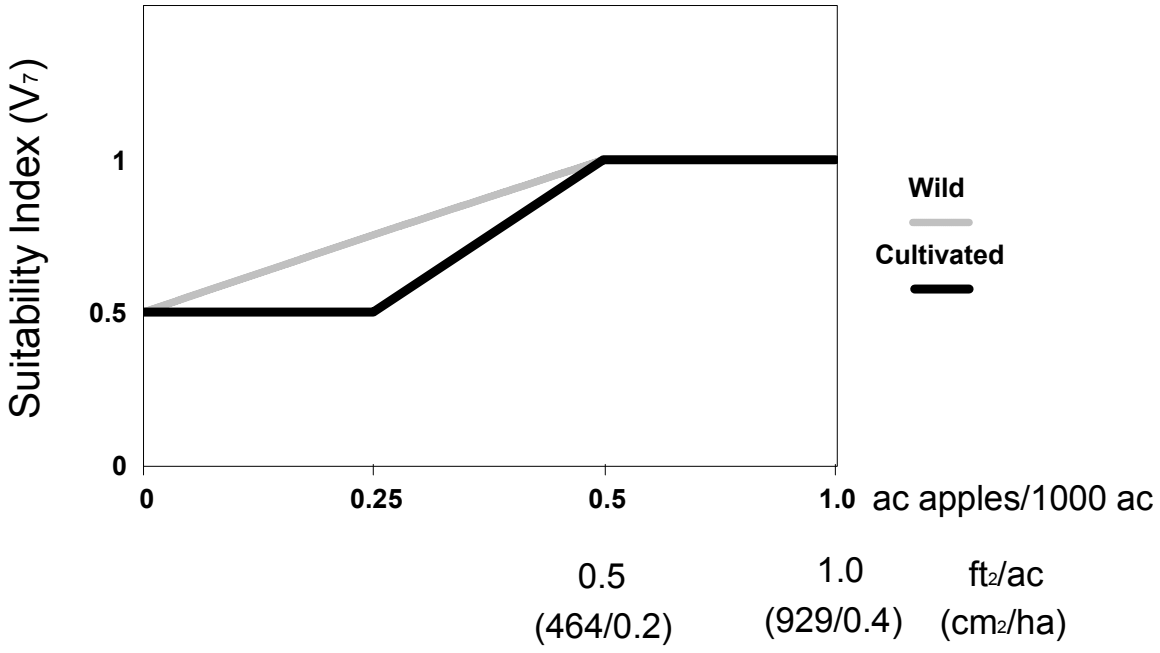


Acres (ha) of blueberries and raspberries under cultivation/1000 acres (405 ha) of forest.

Cover Type	Variable
Forestland (All forest type groups, stand sizes, and stocking) and cropland	V_6

Cover Type	Variable

Apples (wild and cultivated)



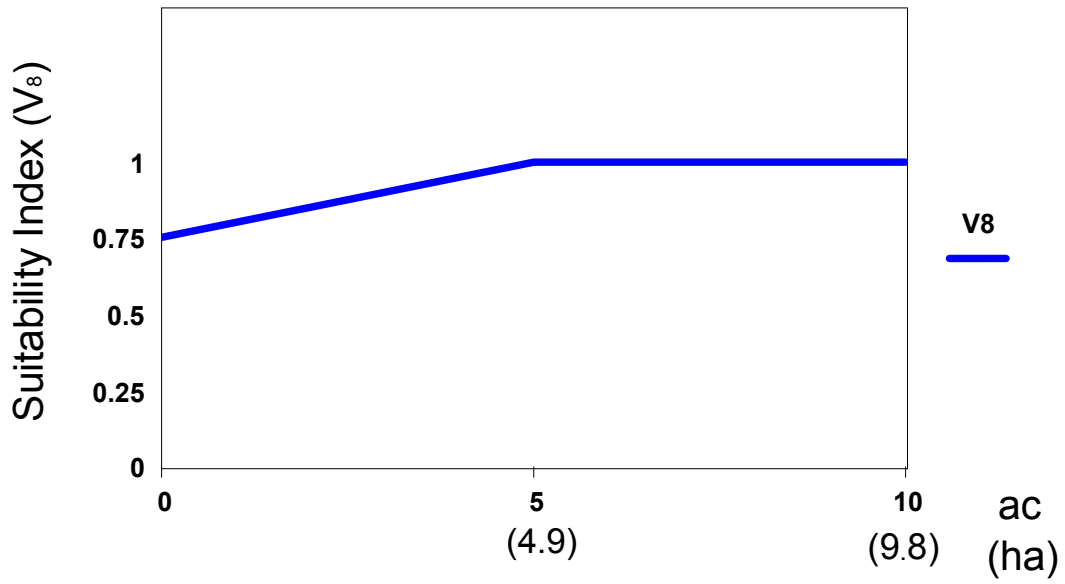
0.5 (464/0.2) 1.0 (929/0.4) ft_2/ac (cm_2/ha)

Acres of apple orchards/1000 acres of forest
Basal area of wild apples (trees > 1.0 inch dbh)/acre of forest

Forestland (All forest type groups, stand sizes, and stocking) and cropland	V_7

Cover Type	Variable

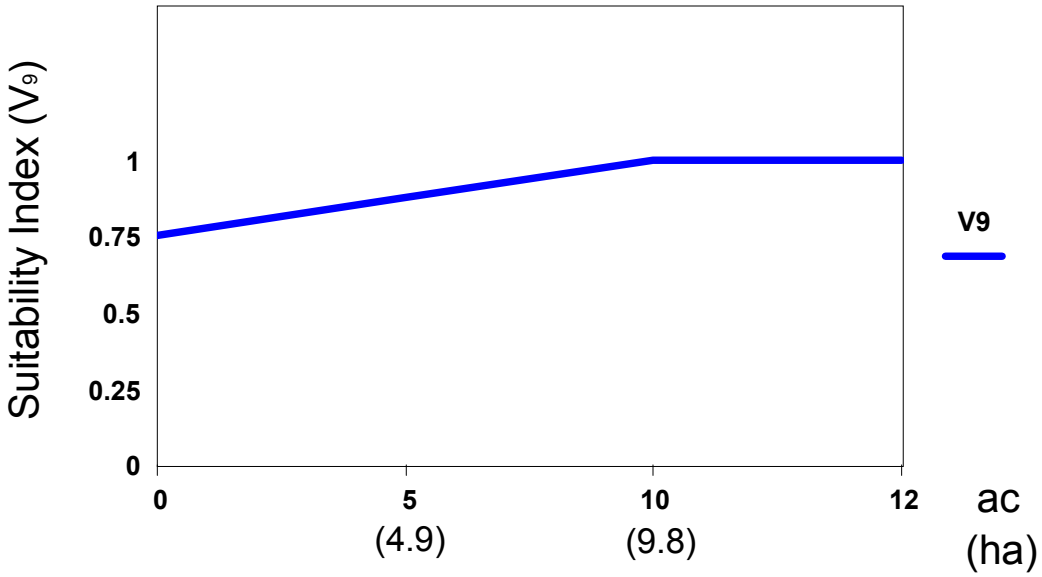
Corn



Acres of corn/1000 acres (ha/1000 ha) of forest.

Forestland (All forest type groups, stand sizes, and stocking) and cropland	V_8

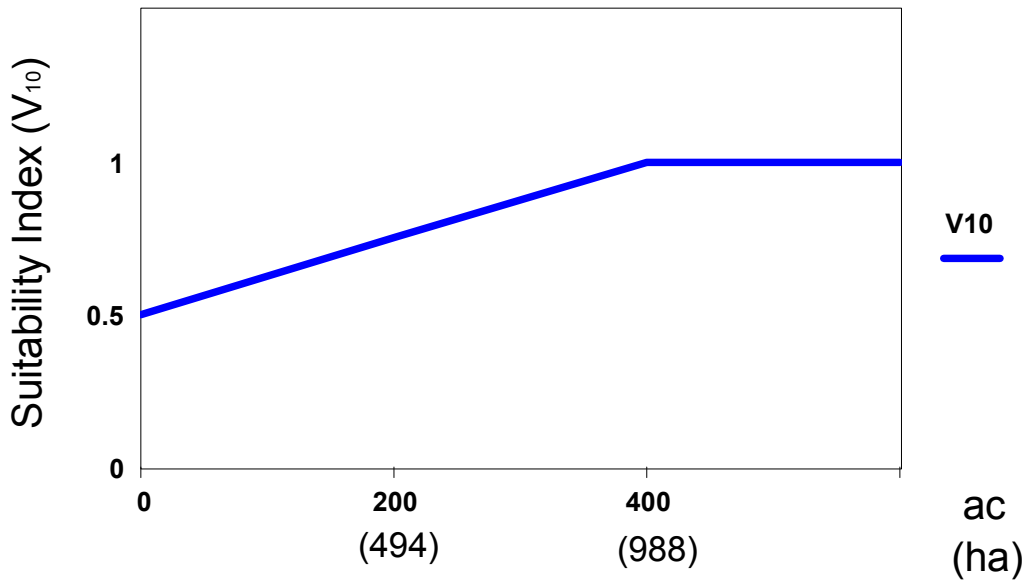
Oats



Acres of oats/1000 acres (ha/1000 ha) of forest.

Cover Type	Variable
Forestland (All forest type groups, stand sizes, and stocking) and cropland	V_9

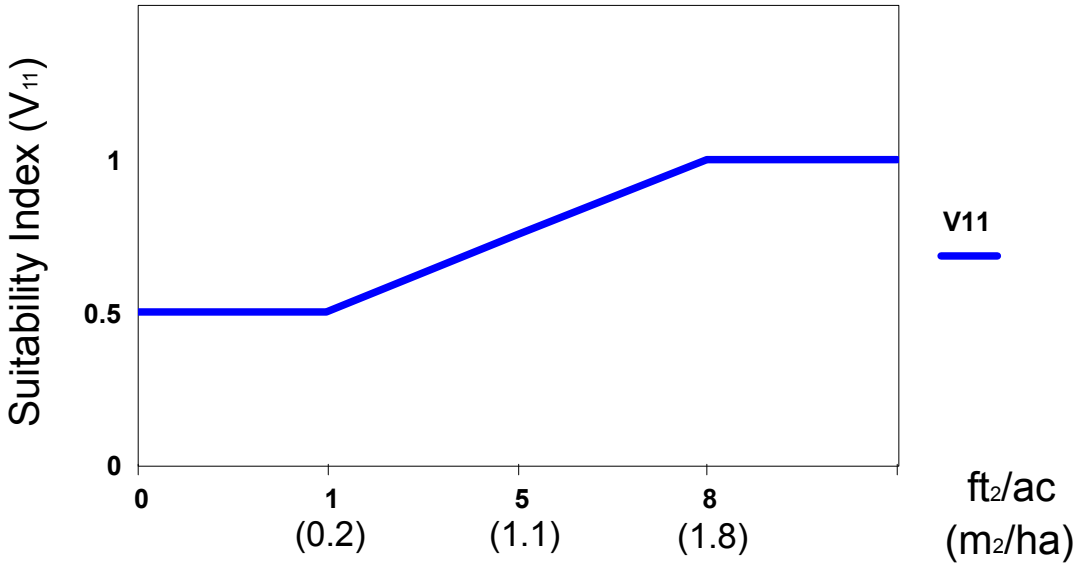
Nuts produced by shrubs



Stem-diversity units/acre (ha) of forest.

Cover Type	Variable
Forestland All forest type groups, stand sizes, and stocking	V_{10}

Nuts produced by trees

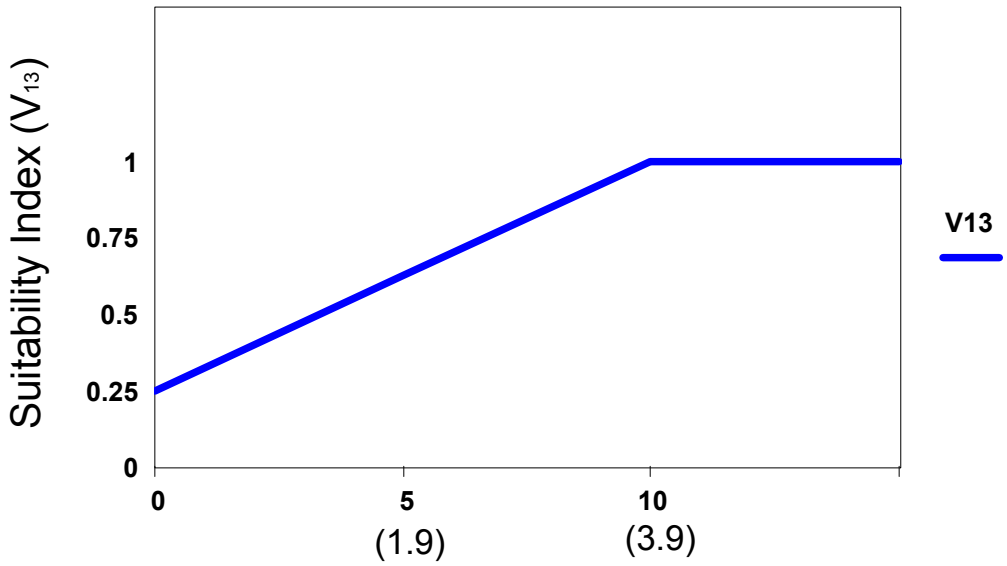


Aggregate basal area of nut producing tree species
(scrub oak: dbh ≥ 1.0 inch; American beech: dbh ≥ 8.0 inches;
other oaks: dbh ≥ 10.0 inches)/acre of forest, multiplied by diversity factor
based on number of species groups present.

Cover Type	Variable
Forestland All forest type groups, stand sizes, and stocking	V_{11}

Variable V_{12} — Removed from the model.

Vertebrates

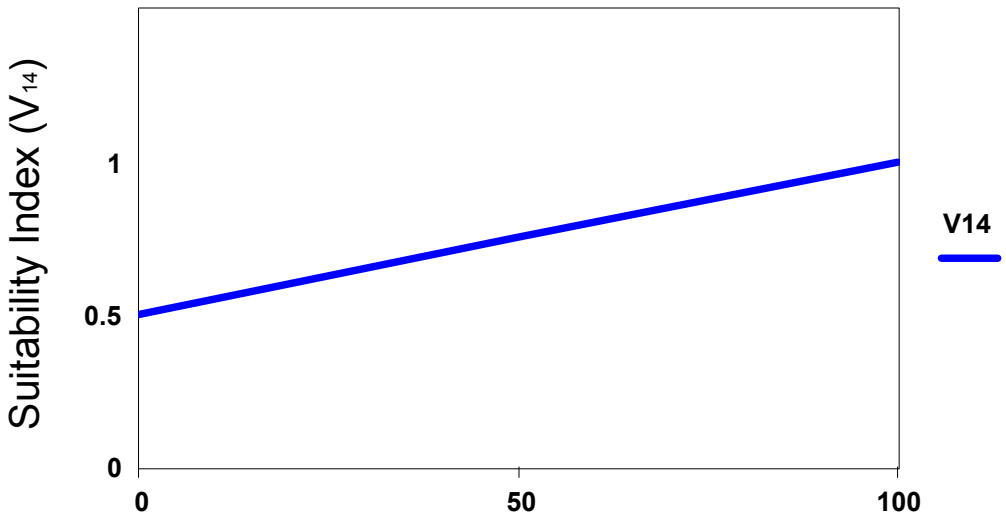


Ungulate units/mi$_2$ (km$_2$).
(1 ungulate unit = 1 deer-sized ungulate)

Cover Type	Variable
Forestland All forest type groups, stand sizes, and stocking	V_{13}

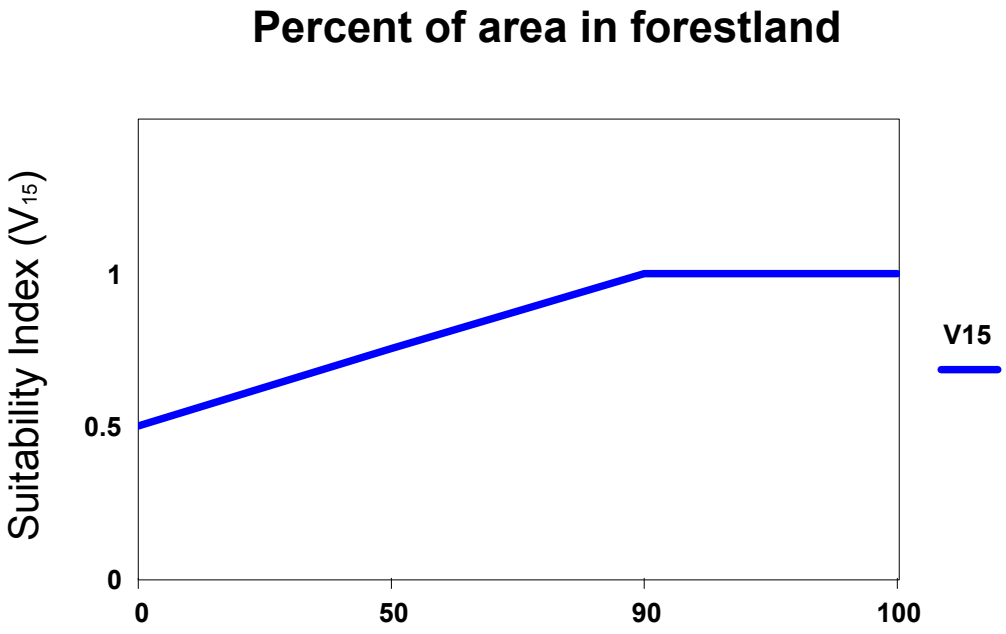
Cover Type	Variable

Interspersion of food sources



Cumulative % forest area in
homogeneous stands <100 acres (40 ha) in size.

Cover Type	Variable
Forestlands and forest/ scrub-shrub wetlands (modified ME-GAP)	V_{14}



% of land area in suitable forestland. (suitable forestland = forested habitat in towns with public road density < 2 km public road/km^2 of town area.

Forestlands and forest/ scrub-shrub wetlands (modified ME-GAP)	V_{15}

Cover Type	Variable
Forestland	V_{16}
All forest type groups, stand sizes, and stocking	

Determining Carrying Capacity

Each WMD was assigned the HSI value developed for the bear habitat region of which it was a part (Table II-2). The number of habitat units (HUs) within each WMD were calculated by multiplying the respective HSI value by the amount of potential bear habitat in the WMD. Carrying capacity was estimated by multiplying the number of HUs in each WMD by the range (and midpoint) of maximum bear densities used in the 1985 assessment (1.5-2.0 bears/mi^2).

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Appendix III

Draft Habitat Suitability Index model for black bear in the conifer-deciduous forests of New England: its application in Maine